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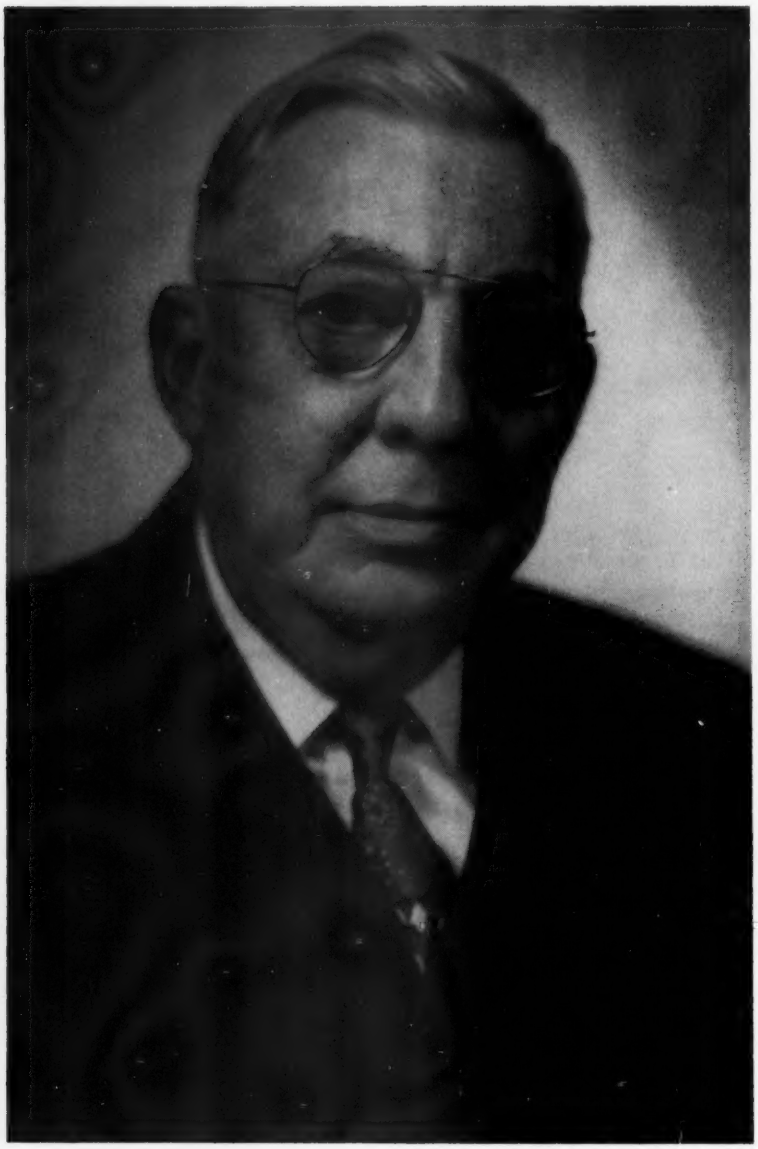

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JOSHUA C. DICKINSON

PRESIDENT OF THE AMERICAN ROENTGEN RAY SOCIETY, 1954–1955

THE AMERICAN JOURNAL OF ROENTGENOLOGY
RADIUM THERAPY AND NUCLEAR MEDICINE

VOL. 73 JANUARY, 1955 No. 1

THE ART OF CLINICAL RADIOLOGY*

By JOSHUA C. DICKINSON, M.D.
TAMPA, FLORIDA

AFTER Röntgen's discovery of the roentgen ray, the group that became interested in this hitherto unknown energy had widely diversified professional interests. Comprising it were physicists, electrical engineers, photographers, physicians and many others.

It soon became apparent that the most important application of the new energy would be in the realm of medicine. The early investigators in this field were immediately interested in its clinical applications. They saw in it a new method of obtaining additional, and sometimes vital, information in their daily clinical problems. These pioneers came to recognize, however, that to interpret the results of roentgen examinations, one must first have a sound basic knowledge of pathology and clinical medicine.

No better example of the recognition of this necessity can be mentioned than the experience of Eugene Caldwell, whom we honor with the Caldwell Lecture. His early training was in electrical engineering. He soon realized that if he were to use the roentgen ray intelligently, it was of first importance that he acquire a basic knowledge of anatomy and clinical medicine. He then devoted the necessary time to obtain a sound medical training.

TECHNICAL PROGRESS

The development of the complicated equipment which is available today has been truly astounding to those of us whose early experience began with static machines, chemical rectification, mercury interrupters, gas tubes, and the like. The present day equipment is, I am sure, more amazing to us of the earlier generations than to those of the more recent generation who were not privileged to enjoy the earlier and sometimes exasperating experiences. The modern technical developments have been of great importance, and without them Radiology as we know it today could not be practiced.

With these advances, however, there has been an ever-increasing tendency on the part of the radiologist to focus his interest on the use of equipment rather than to center it on the patient as his first and primary interest. Instead of making the

* President's Address delivered before the Fifty-fifth Annual Meeting, American Roentgen Ray Society, Washington, D. C., September 21–24, 1954.

equipment his slave, in too many instances he has become a slave to it. Often his only knowledge of a case is that a requisition has been received directing that a certain examination be carried out on a patient designated by a certain number. Frequently he does not see the patient, and furthermore, he has no direct contact or actual consultation with the referring physician. In such a relationship, he certainly is not in a position to discharge his full obligation as a consultant.

THE CLINICAL RADIOLOGIST

All too often in clinical conferences the question asked is "What did the x-ray show?" rather than "What is the opinion of the consulting radiologist?" Too, it is not uncommon to have a patient present himself with this remark: "My doctor wants you to make an x-ray picture of my stomach so that he can find out exactly what the condition is. Then he will know just how to proceed." If in the conduct of this examination the radiologist confers with the patient, makes such examinations as he thinks may be indicated, takes the history intelligently, displays a personal interest in the problem and upon completion of the examination tells the patient that he will discuss the problem with the referring physician, that patient knows that he has seen a doctor. Also, he realizes that the radiologist's contribution is of importance because of the professional opinion rendered and that the responsibility no longer rests solely on the referring doctor. If a radiologist is to fulfill his obligation to the patient, he must know the pertinent factors in order to discuss the case intelligently with the physician who has referred the patient to him.

In some circles, radiologists are only supposed to see referred patients and carry out the direction of the referring physician. This view holds in certain groups as applied to therapy. A surgeon presumes to tell a radiologist when, where, and how to treat. This position is just as absurd as for the radiologist to attempt to tell a surgeon when, where, and how deep to cut.

The pioneers in our special field were primarily clinicians. Hickey, Holmes, Pancoast, Manges, Crane—I could go on and on naming the men who laid the foundation for Radiology as we are privileged to enjoy it today. These early radiologists were keen clinicians who had the God-given ability to make accurate observations and interpret their findings in terms of pathology.

The radiologist who bases his opinions upon the fact that a given film looks like something he has seen before is a picture reader and not a clinical radiologist. If shadows cannot be interpreted in terms of pathological changes, the interpretation of roentgenograms becomes purely a guessing contest. In order to be able to recognize pathological shadows, however, the radiologist first must be familiar with the normals and the variables that may be encountered.

It has been said that there is little place for the art of clinical medicine in the practice of Radiology. This belief is entirely dependent upon the attitude of the radiologist. I am sure that one who holds to this expressed view misses much and perhaps the nost important source of gratification that can come to a physician. If radiologists will be real clinicians, we need have no fear as to the future of our specialty. If the contrary is true, then clinicians will and should take over the field of Radiology.

THE TRAINING OF RESIDENTS

To those who are engaged in training residents in Radiology I would make an earnest appeal to plan the program so that the trainees have ample opportunity for training in a proper physician-patient relationship. The course should be planned in such a way that all of their time is not spent in research and mastering complicated gadgets, or even in learning to calculate hypothetical depth doses for deep-seated tumors, the exact extent and location of which at best can be only a matter

of speculation. Let them not miss the concept of the patient as an individual like themselves, beset by social, economic, and personal stresses as well as those particularly medical. The development of the concept of the patient in teaching, rather than the disease, is a major aim in medical education today which deserves every encouragement in Radiology as well as in other branches of medicine. Also, when a resident has completed his resident training and has been certified by the American Board of Radiology, he should be made to realize that he still must prove himself capable of being looked upon as a competent consultant in clinical Radiology.

"ART IS LONG"

The art of healing is as old as recorded history. "Life is short and art is long, the occasion fleeting, experience fallacious and judgment difficult." This familiar aphorism of Hippocrates is as true today as in his time. No matter how dramatic and far-reaching the magnificent strides of medicine as a science, the healing art is never outmoded in the successful treatment of the sick. It may have been overshadowed by the spectacular scientific developments of recent years, or neglected and ignored, to the detriment of medicine, but there are hopeful signs on the horizon today which indicate that the servant, Science, and the mistress, Art, are being merged into a happy union of mutual understanding and respect. The science of medicine would be impotent indeed without the art to adapt even the greatest scientific triumphs to human use.

As medicine comes of age in our time with the fusion of scientist and healer, this synthesis should find adequate expression in Radiology. Our specialty must not be allowed to lag in this respect. I would not minimize the importance of scientific study; neither would I fail to point out, as did O'Brien, "the error of leaving the path of clinical experience to follow too far along a road paved with fascinating numbers." Discussing "Radiation Therapy" in the April, 1954, number of the JOURNAL, this author* further observed, in substance, that precise measurements with every dimension exact to one millionth of a millimeter are important, but relatively so, for it is the place to be measured which is of paramount importance. The radiologist is fortunate to be an expert mathematician, but to apply radiation successfully in the healing of the sick, he must have basic knowledge of the human body coupled with clinical judgment. The position of the radiologist is pictured as analogous to that of the artist; . . . "Given the most scrupulous analysis of the pigments—the most precise measurement of each color and shade, and most of us would still be unable to produce the paintings of a Goya or a Velazquez." True enough, this information would not make artists of us. The artist must have knowledge of the infinitely variable human needs and desires, which are not reducible to units of measurement. He gains such knowledge only from sympathetic observation enriched by experience.

Medicine has the unique distinction of being the only profession which labors incessantly to destroy the reason for its very existence. The physician seeks early and late to cure, which basically means to care for. Since the founding of this Society at the turn of the century when knowledge of the roentgen ray was but five years old, the physician, his understanding, his wisdom and his philosophy have undergone remarkable changes. From this evolutionary process there has emerged the physician of today, who, at his best, is the healer leading the way back to a primary preoccupation with the person as an individual human being and the scientist contributing the power of analysis and integration which has brought to fruition this heyday of scientific development.

Clinical medicine has matured. In clinical Radiology at its best we care for the patient. The highest possible standards of

* O'Brien, F. W. Radiation therapy. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., April, 1954, *71*, 650–658.

scientific precision are no deterrent to compassion or any of the other generous gifts of the healer. The goal is cure through understanding. In the words of Osler, "The practice of medicine is an art, not a trade; a calling, not a business; a calling in which your heart will exercise equally with your brain." The compensations are abundant and abiding. What could be more rewarding, what could make us feel more necessary and important and proud of our calling than the knowledge that fellow human beings—friends and strangers alike—lean on us and on no other for relief from the ills of the flesh and even at times look to us for their very life? The challenge is greater today than ever before, but we shall meet it, for courage, the cornerstone of character, is running high in our midst. Let us then cultivate the art of clinical Radiology wholeheartedly and nurture it properly so that it may fulfill the great promise which it holds for the future.

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XERORADIOGRAPHY*

By JOHN FAUNCE ROACH, M.D.,† *and* HERMAN E. HILLEBOE, M.D.‡
ALBANY, NEW YORK

IN THE event of the explosion of an atomic bomb over one of the major cities in the United States, the numbers of casualties produced and requiring emergency medical care would be tremendous. The preparation of medical organization and facilities for such a catastrophe is a prodigious task not a small part of which belongs to the field of radiology.

Even if a portion of the existing medical facilities will be operable and undamaged after the explosion, it is obvious that they will not be able to accommodate the flood of injured which, if they are to survive, must be treated within the first forty-eight hours. It therefore becomes necessary to provide additional medical resources in the form of improvised mobile hospitals in the zone of damage. Inasmuch as roentgen examinations will be necessary in the handling of fractures, foreign bodies and internal injuries, mobile roentgen-ray units will form an essential part of the emergency services.

It is relatively simple to provide light weight, rugged, mobile roentgen-ray generating equipment. This is commercially available today in units capable of operating at desirable levels as high as 100 ma. at 85 kv. When, however, one considers the questions involved in roentgen film and its processing such as (1) the difficulties in providing and maintaining sufficient stockpiles, (2) the necessity of protecting those stockpiles from radiation during both storage and transfer to the point of use and (3) the provision of darkroom facilities, chemicals and water, at the point of use, one is overwhelmed by the magnitude of the logistic problem as well as its cost.

Xeroradiography, on the other hand, offers a simple, safe and inexpensive medium for the recording of roentgen images. No darkrooms or solutions of any type are needed. No lead-lined storage vaults are required since radiation has no deleterious effect on the xeroradiographic equipment. There is no film deterioration problem. No transport of large supplies is involved, since one uses xeroradiographic plates over and over again. No special skill is required and the same roentgen-ray machine needed for conventional roentgenography can be used in xeroradiography without any modifications.

Xeroradiography is fundamentally different from conventional roentgenography; it is totally photoelectric in nature, whereas standard film is chiefly photochemical in character. Since it is purely a photoelectric mechanism, no solution or liquid of any sort is required. Its name is derived from the Greek word "xeros" meaning dry.

Xerography, the photographic counterpart of xeroradiography, was first described and patented by a physicist named Carlson in 1937. In 1944, patent rights were acquired by the Batelle Development Corporation of Columbus, Ohio, which experimented with the process at its Memorial Institute. In 1947, the Haloid Company of Rochester, New York, became licensed to use xerography; it was through this company and the General Electric X-ray Corporation that we became aware of the medical potentialities of the process.

It is common practice among nonphysicists to divide materials into two main groups: conductors and insulators. Furthermore, these materials retain their electrical properties within certain practical and predictable boundaries even though their en-

* Presented at the Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.
† Professor of Radiology, Albany Medical College, Albany, New York, and Radiology Consultant to the Office of Medical Defense, New York State Health Department.
‡ Commissioner, New York State Department of Health and Chief Medical Officer, New York State Civil Defense Commission.

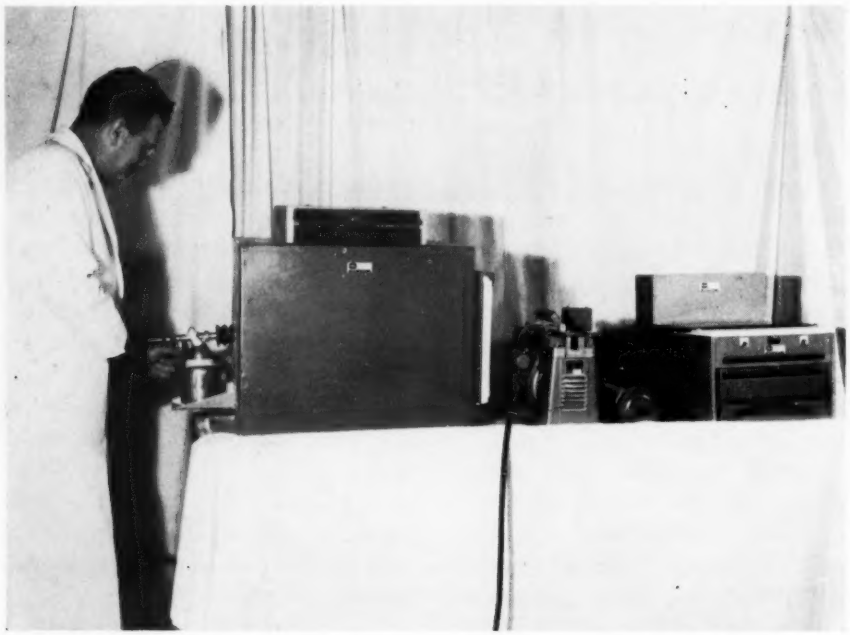

FIG. 1. Powder cloud chamber, air compressor and plate charging unit.

vironmental state varies widely.

There is, however, a group of materials, the so-called semiconductors, whose electrical conductivity may temporarily change whenever they are exposed to radiant energy. In the normal state their specific resistivities may be as high as 10^{15} ohm-cm., a figure considerably higher than that of many of the common insulators. In the energized environment, however, the specific resistivity may be decreased by a factor of 1,000 or more, only to return to the

FIG. 2. Viewing and rotary brush equipment.

resting level of 10^{15} ohm-cm. soon after the radiant energy ceases. Thus, under normal conditions, these substances are excellent insulators; in the energized state, they become relatively good conductors. One of the large number of substances which have these photoconductive properties is selenium. In its elemental form this material is used in the present xeroradiographic process.

The xeroradiographic plate consists of a sheet of metal, such as aluminum or brass, on which has been deposited by carefully controlled evaporation, a thin layer of selenium. (For brevity, we refer to the xeroradiographic plate as the xeroplate.) The metal base plate provides physical support to the photoconductive selenium and also serves as an electrical reservoir to or from which electrical charges may flow during the roentgen-ray exposure. Since in its charged state the plate is sensitive to radiant energy over a wide spectral band including that of visible light, it is encased within a thin wooden frame to which is fitted a tight sliding cover in the same fashion as the conventional photographic film holder.

In use, the xeroradiographic plate is sensitized by passing closely over its selenium surface a group of wires charged positively to a sufficiently high level to produce a corona. This results in ionization of the surrounding air; the positive ions in the air are repelled by the positive corona wires and flow to the nearby selenium to deposit

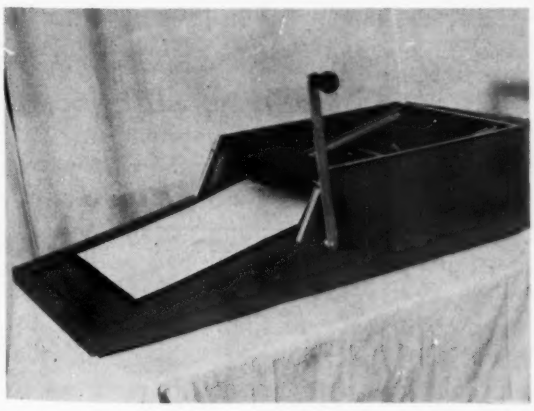

Fig. 3. Paper transfer unit.

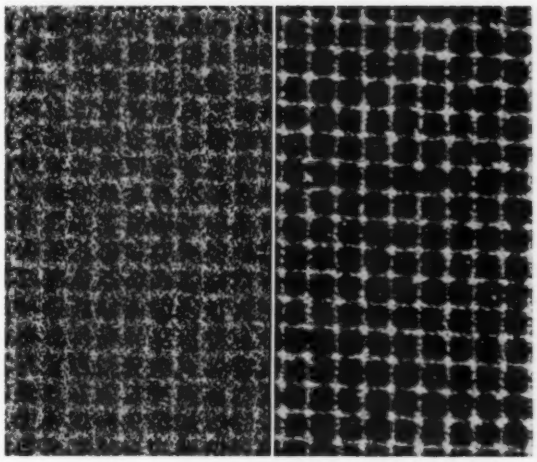

Fig. 4. Photomicrographs of radiographs of 160 mesh bronze wire screening (160 openings per inch). On the left, Eastman Kodak Blue Brand film in a cardboard holder. On the right, a xeroradiographic plate. (23× magnification.)

their charges. Thus, in the linear transit of the corona wires over the plate, a uniform charge is spread over the selenium-coated surface of the plate. If the charged plate is then exposed to roentgen rays, those portions of the selenium upon which the radiation impinges immediately become conductive and the charge which had been held on the surface of the selenium flows into the metallic base plate and is dissipated at any given point proportional to the amount of radiation striking that point. If an object is placed between the source of the roentgen rays and the charged plate, some of the energy will be absorbed by the object, and will not reach the plate. It follows then that the area of the plate covered by the object will not lose its charge as does the surrounding zone which has received the full effect of the radiation. Furthermore, since most substances are of mixed composition and varying thickness some radiation will pass through the object in an intensity pattern reflecting the varying radiodensity of the interposed object. Thus, if a proper quantity and quality of radiation is used for the exposure, there will remain on the selenium a charge which is a representative electrostatic image of the size, shape and radiodensity of the interposed object.

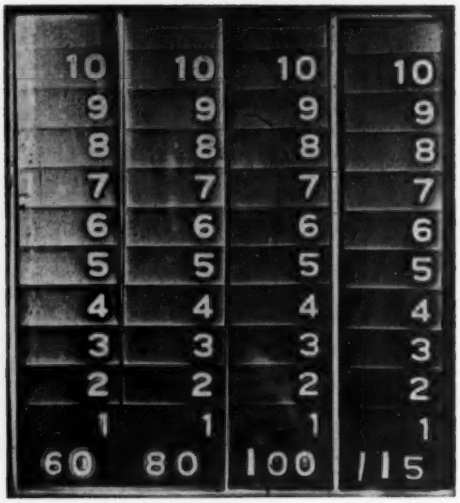

FIG. 5. Aluminum step-wedge xeroradiographs made at 60, 80, 100 and 115 kv. (peak). (Wedge varies in thickness from 5 to 33 mm.)

This image is, of course, invisible to the eye but it can be detected and mapped electrometrically. It is more convenient, however, to render the latent image visible by offering to the charged pattern on the plate finely divided powder particles which are negatively charged. The powder granules are attracted to and held firmly by the positively charged area of the plate. The quantity of powder, deposited at any given point and therefore the density of the image at that point, is proportional to the quantity of charge remaining on that point. Thus a clearly visible image is produced which may be interpreted with ease by the radiologist. In practice, the powder is applied by placing the exposed xeroplate in a powder cloud produced within an enclosed chamber by a compressed air gun.

If a permanent record is required, the powder image may be transferred to paper by laying on the surface of the selenium a piece of paper coated with a special adhesive. Both plate and paper are pressed together between two rollers. When the paper is peeled off the plate it carries most of the original powder image. If desired, the permanent record may be made on a transparency simply by suitable choice of materials.

After the image on the xeroplate has served its purpose, the plate is cleaned by brushing its surface with a soft rotary brush which effectively removes any residual powder. The plate is then ready for recharging and re-use. The number of times a plate can be used is undetermined at present. We have used some plates hundreds of times and have reason to believe that a thousand or more exposures per plate can be expected. Indeed, plates seem to improve with use as the result of the brushing away of the minor surface defects in the selenium.

Xeroplates are quite rugged, both physically and electrically. They may be subjected to considerable handling without effecting their photoconductive qualities or the ability to maintain a powder image once it is formed. One must be careful, however, to prevent sharp or abrasive objects from scratching the delicate selenium surface. Electrically, selenium plates are very stable. Although there is a measurable decay of the potential on the surface of the selenium after charging, it is maximal during the first two minutes and thereafter is negligible for several hours. In practice, however, since the plate charging procedure requires only a few seconds, one usually charges the plate just before the roentgen-ray exposure is made.

The entire xeroradiographic process is a very brief operation since the plate can be powdered in thirty to forty seconds. It is therefore possible to have a xeroplate ready for interpretation within one minute from the time the roentgen-ray exposure is completed. It should be noted that the charging, powdering, viewing and plate cleaning equipment, all of which operate on 115 volt 60 cycle current, may, if necessary, be stored and operated in the same room as the roentgen-ray machine as long as one charges a plate before each exposure.

The effective speed of xeroplates is at the present time between that of Eastman Blue Brand film in cardboard holders and the same film in cassettes using Patterson Par Speed intensifying screens. It is closer to

the former than the latter. Our present plates, however, are approximately eight times faster than those we had six months ago, and there is every reason to expect that further increase of speed can be obtained without the use of intensifying screens. For six months we have been making xeroradiographs of the extremities, hips, shoulders, cervical spine and ribs using techniques essentially the same as those we use in conventional roentgenography. The heavier parts such as skull, abdomen, pelvis and lumbar spine require exposures distinctly in excess of that needed for standard filming of those parts. The adaptation of intensifying screens for use with a selenium plate presents a real problem but it is one which does not in any way seem insurmountable.

The resolving power of xeroplates when compared with that of film is excellent. Measurements made by radiographing fine wire screening of known size demonstrate that xeroplates are vastly superior to Blue Brand film in cassettes with par-speed screens and better than the same film in cardboard holders. The ultimate in detail theoretically possible on selenium plates is far from attained. Using light in the visible wavelengths, as many as 56 lines per millimeter have been clearly recorded on xeroplates.

A significant factor in producing this fine definition is found if one studies the pattern and intensities of the fields of force about an electrostatic charge which lies on a plane surface such as the xeroplate. It can be shown that the strength of the field is considerably greater at the edge of a charged area than it is at the center. This is particularly pronounced if the edge is very sharp. The increase in field strength results in the deposition of greater amounts of powder at the boundaries of charged areas and thus greatly augments local contrast.

Xeroplates with present dusting powders and viewing conditions do not afford the wide extremes of contrast which are available in roentgen film and further developmental studies along these lines need to be done. However, with the currently available materials, aluminum step-wedge measurements show easily detectable contrast gradations over a wide range of kilovoltage and wedge thickness.

We are currently involved in a clinical evaluation of xeroradiography in which we are routinely studying patients admitted to the Emergency Department of the Albany Hospital. These patients are studied by both xeroradiography and conventional roentgenography. Multiple readers are independently interpreting the plates and recording their findings. These data will then form the background of a statistical study which will be the basis of a future clinical report.

We have also begun field trials in xeroradiography in simulated atomic attacks on major cities in New York State.

Though we are still limited in our experience, it is our impression that xeroradiography has great potentialities in both civil defense and everyday roentgenography.

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Albany, New York

The authors wish to express their appreciation for the invaluable aid given them by Messrs. C. H. Renaud and D. B. Slauson of the General Electric Company and Dr. H. Clark and Mr. J. Rosenthal of the Haloid Corporation.

AORTIC SINUS ANEURYSM ASSOCIATED WITH COARCTATION OF THE AORTA*†

By WILLIAM DUBILIER, JR., M.D., THOMAS L. TAYLOR, M.D., *and* ISRAEL STEINBERG, M.D.

NEW YORK, NEW YORK

THE presence of aortic sinus aneurysm associated with coarctation of the aorta, to our knowledge, has not been previously reported. With the advent of angiocardiography demonstration of the site, nature and relationships of the coarctation of the aorta has become possible.[2,3] In addition, valuable information may be obtained concerning the remainder of the aorta.

In a series of 58 angiocardiographic studies of coarctation performed at this center, 3 cases of localized aneurysmal dilatation of the aortic sinuses were discovered. Congenital or mycotic aneurysms of the aortic sinuses with coarctation of the aorta have been reported in 3 instances, but these were more localized outpocketings into the mycardium from an aortic sinus rather than a generalized dilatation of the sinuses.[4,7,9] Dilatation of the ascending aorta is a common finding in coarctation of the aorta. However, in the cases herein reported, the dilatation was most pronounced in the aortic sinuses themselves. Our 3 patients were young adult males, varying in age from seventeen to twenty-three years. Hypertension in the arms was severe in 2 cases, but only moderate in the other. All had histories and physical findings typical of coarctation of the aorta.

The chest roentgenograms of the 3 cases (Fig. 1*A*, 2*A* and 3*A*) exhibited rib notching, deformed aortic silhouettes and left ventricular enlargement. The cardiac contours showed no evidence of the aortic sinus aneurysms. On the other hand, angiocardiography (Fig. 1, 2 and 3) revealed dilatation of all the sinuses, but the most marked outpocketing occurred in the right anterior sinus. There was an increase both in the greatest (horizontal) distance between the anterior and posterior sinus walls and in the vertical length of the sinuses themselves (Table 1). In no case was there calcification of the sinuses nor was the aneurysm large enough to cause an impression upon the cardiac chambers. Significant dilatation of the ascending aorta occurred in only 1 case. This patient also had the greatest dilatation of the aortic sinuses (Fig. 2). At operation for correction of the coarctation, the usual type of coarctation was found. No evidence of aortic sinus aneurysm could be recognized by the surgeon on the exposed surface of the heart.

TABLE I

MEASUREMENTS IN AORTIC SINUS ANEURYSM

Case Number	Horizontal Diameter mm.	Vertical Diameter mm.
I (NYH No. 632 904)	55	56
II (NYH No. 614 924)	71	63
III (NYH No. 582 445)	44	35
Normal	30–38	15–30

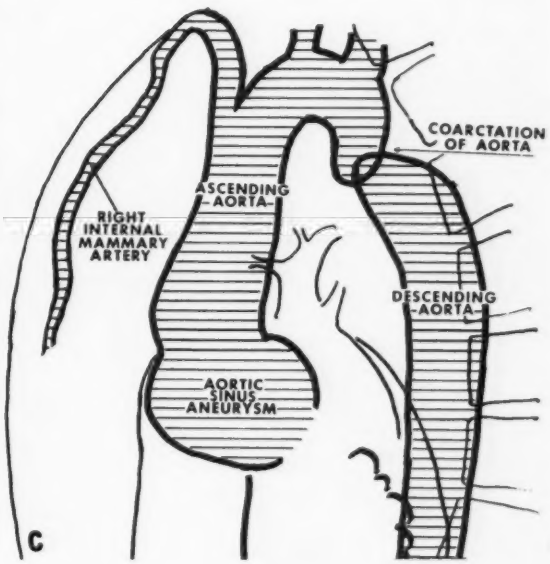
DISCUSSION

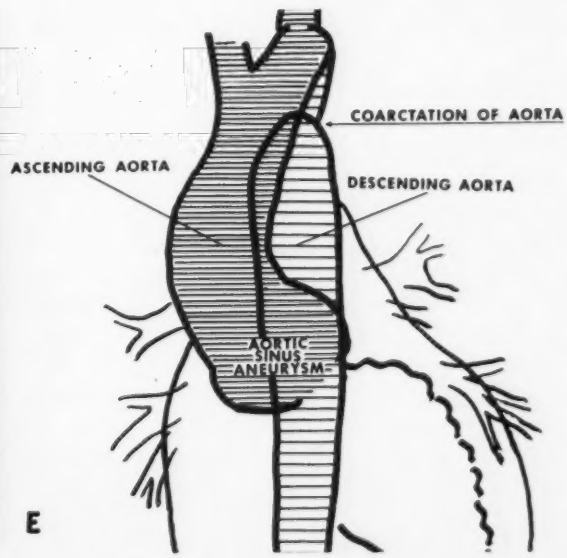
The usual type of aortic sinus aneurysm referred to in the literature is an outpocketing into the ventricular wall with a small opening from the aortic sinus.[8,10] They are usually due to syphilis or are mycotic in origin, but they may be congenital. In contrast, the aneurysmal dilatation referred to in this report is a diffuse enlargement of the aortic sinuses. It is probable that the association of aneurysmal dilatation of the aortic sinuses with coarctation of the aorta is not uncommon. Its

* From the Department of Radiology of The New York Hospital-Cornell Medical Center, New York.

† Aided by a grant from the Mallinckrodt Chemical Works.

FIG. 1. Seventeen year old male (NYH No. 632904). Blood pressure 160/110 upper extremities; absent, lower extremities. Complained of dizziness and headaches. (*A*) *Conventional frontal roentgenogram* shows slight rib notching, enlarged left ventricle and inconspicuous aortic knob. (*B*) *Left anterior oblique angiocardiogram* and (*C*) *Tracing*. Dilated aortic sinuses associated with coarctation of the aorta are illustrated. There is no dilatation of the ascending aorta. (*D*) *Frontal angiocardiogram* and (*E*) *Tracing*.





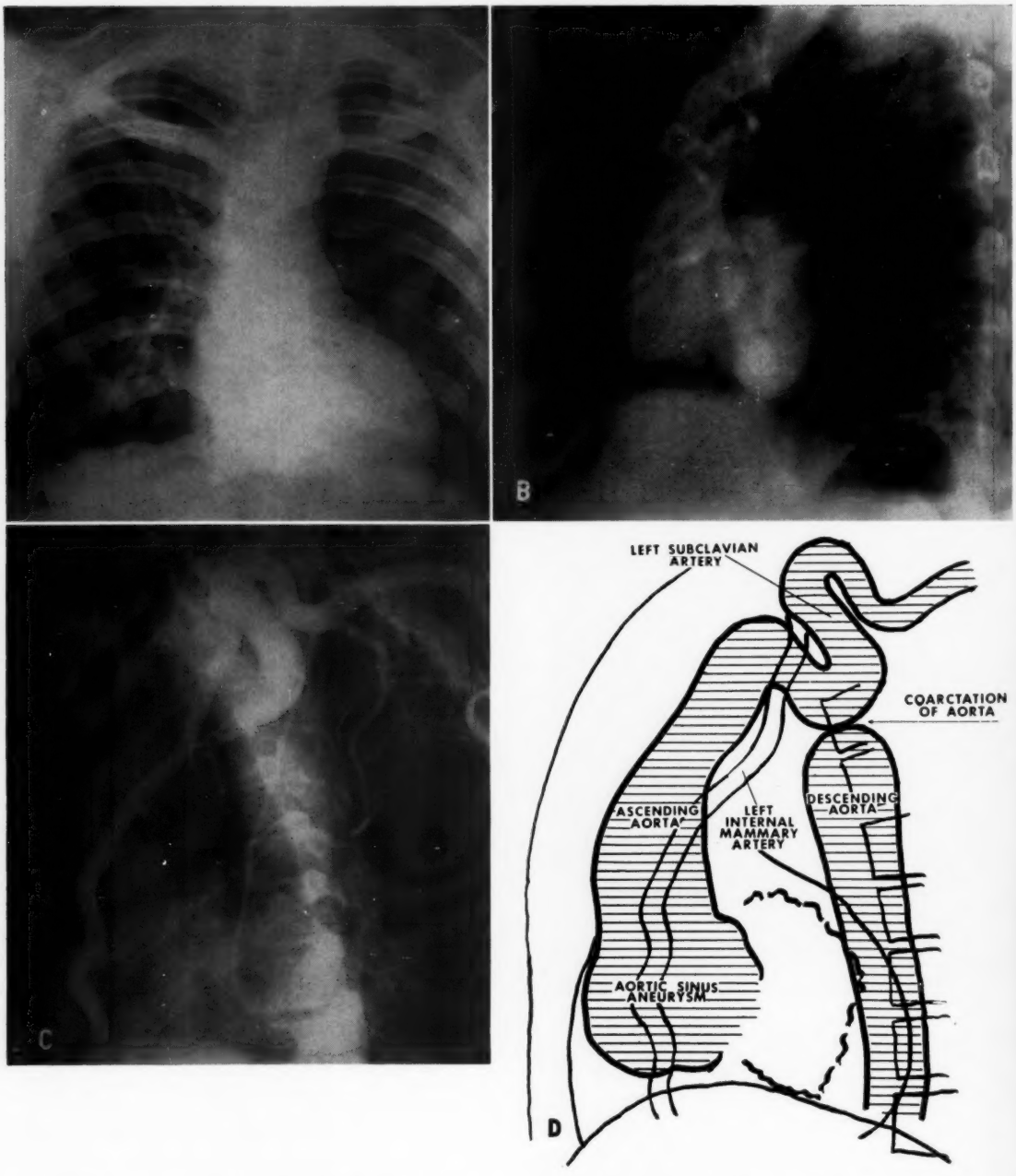
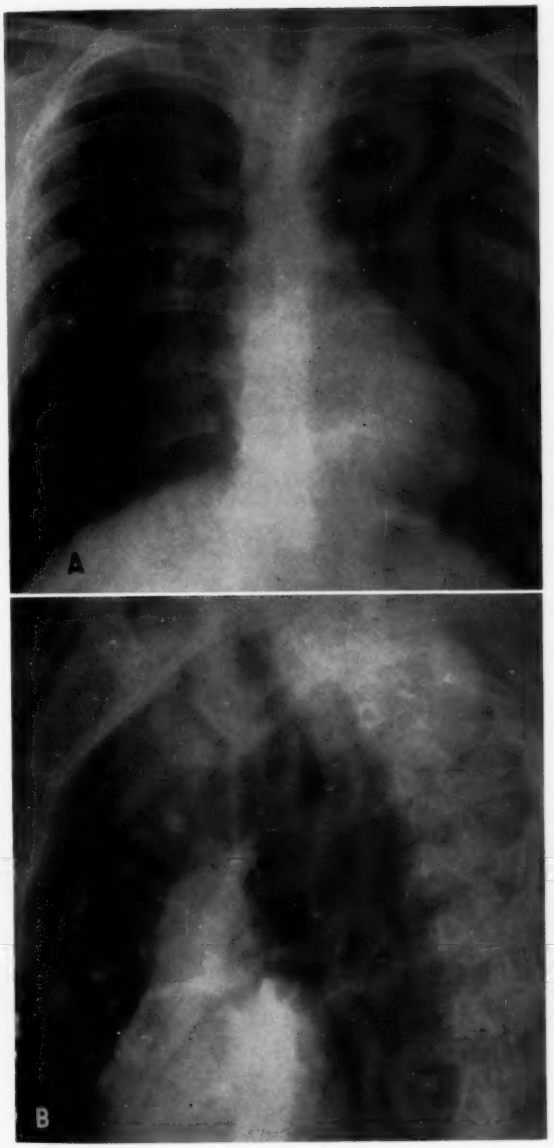


FIG. 2. Eighteen year old male (NYH No. 614924) complained of frequent epistaxis and headaches. Blood pressure 196/13 upper extremities; unobtainable lower extremities. (*A*) *Conventional frontal roentgenogram* reveals rib notching, dilated aortic arch and prominent left ventricle. (*B*) *Left anterior oblique roentgenogram* (Fairchild magazine, 9 by 9 inches) shows opacification of the left ventricle and ascending aorta but fails to demonstrate the coarctation. (*C*) *Retrograde aortogram*, in order to better visualize the coarctation, exhibits opacification of the left subclavian artery and aortic arch. (*D*) *Composite tracing* of (*B*) and (*C*) illustrating the aortic sinus aneurysm, dilated ascending aorta and coarctation.



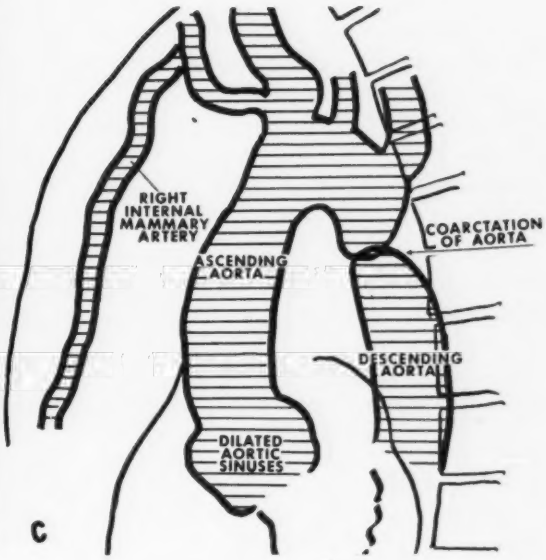


FIG. 3. Asymptomatic, twenty year old male (NYH No. 582445) with history of hypertension since childhood and blood pressure of 200/120, upper extremities and 135/120 in lower. (*A*) *Conventional frontal roentgenogram* with rib notching and enlargement of the left ventricle. (*B*) *Left anterior oblique angiocardiogram* and (*C*) *Tracing.* The aortic sinuses are only slightly dilated, while the ascending aorta is of normal caliber.

detection would be unlikely without angiocardiography. Furthermore, because of their intracardiac location, only very large aneurysms may be expected to be identified by the surgeon at operation.

Hamilton and Abbott[6] found that 22 per cent of patients with coarctation died of rupture of the aorta. As a cause of death this was second only to cardiac failure (30 per cent) and more common than cerebral hemorrhage (12 per cent). Aneurysmal dilatation of the ascending aorta was a common association. It is probable that in the presence of an aneurysm proximal to the coarctation, rupture of the aorta in this region is more likely because of increased pressure and weakening of the wall. In Hamilton and Abbott's extensive series the most common site of rupture was immediately above or close to the aortic valves. This location corresponds to the site of the aneurysms noted in our cases. There have also been several reports of aortic rupture with coarctation in the more recent literature.[1] Therefore, the demonstration of an aortic sinus aneurysm is of obvious signifi-

cance and suggests a serious prognosis.

The etiology of aneurysmal dilatation of the aortic sinuses in coarctation of the aorta is not entirely certain. The possibility that this may represent a second congenital defect cannot be ruled out. However, it is logical to suspect that the aneurysmal dilatation is related to the hypertension. Surgical repair of the coarctation is indicated in these cases.[5] This is especially desirable because correction of the coarctation may be expected to correct the hypertension and to alleviate the danger of rupture or further enlargement of the aneurysm. As yet, it has not been determined whether the size of the aneurysm may diminish after relief of the hypertension. In 1 case (Fig. 2), no change in the configuration and diameter of the aneurysm or the diameter of the mid-portion of the ascending aorta could be detected angiocardiographically six months after operation, although a satisfactory drop in pressure had occurred.

SUMMARY AND CONCLUSIONS

Three cases of aneurysmal dilatation of the aortic sinuses associated with coarctation of the aorta are presented. The occurrence of this association has not been previously recognized. The possibility of rupture of the aorta at this point and the prognosis and treatment are discussed.

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ADDENDUM

Since this paper was submitted for publication, diagnosis by retrograde aortography of a congenital aneurysm of the right sinus of Valsalva, but without coarctation of the aorta, has been reported. (Falholt, W., and Thomsen, G. Congenital aneurysm of right sinus of Valsalva, diagnosed by aortography. *Circulation*, 1953, *8*, 549–553.)

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Vol. 73, No. 1

LYMPHATIC CYSTS OF THE MEDIASTINUM

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INTRATHORACIC lymphatic cysts or cystic hygromas are relatively uncommon but must be considered in the differential diagnosis of mediastinal masses. These cysts of lymphatic origin may vary from a multilocular tumor which is intimately associated with the great vessels and other mediastinal structures, to a simple thin-walled unilocular cyst which can be readily enucleated from the mediastinum. The gross and microscopic characteristics are similar to those seen in the more familiar cervical hygroma or lymphangioma of childhood. The most common type of cystic hygroma encountered in the thorax is the cervicomediastinal lymphangioma where there is a downward extension of the cervical lesion into the mediastinum. Gross and Hurwitt[3] reviewed the findings in 21 such cases. The roentgenogram of a child with a cervicomediastinal cystic hygroma is illustrated in Figure 1. Less common are those cases considered in this paper in which the mediastinal lesion is the only mass present.

Certain authors[4] feel that the multilocular cysts alone can be considered to be hygromas. This would seem to be an arbitrary line of distinction since the typical microscopic findings of a lymphangioma may be encountered in the wall of a thin unilocular cyst (Fig. 2). Some thin-walled mediastinal cysts containing similar clear watery fluid show no microscopic characteristics which indicate a lymphatic origin, and such cysts may have a different derivation. It must be remembered, however, that sometimes only small portions of the wall of a lymphatic cyst show those microscopic features which indicate its lymphogenous origin.

Harley and Drew[4] collected 7 cases of multilocular cystic hygroma from the literature and added another case. These were the only reports which they could find of entirely intrathoracic lymphatic cysts which were multilocular. Their paper is recommended for a review of the subject. Since their paper appeared in 1950 several additional case reports have been published, and the lesion is less rare than the literature would suggest.

Lymphatic cysts usually occur in either the superior or anterior mediastinum. They are apparently more common on the right side. Not infrequently a portion of the cyst is in close proximity to the trachea. The lesion usually causes no symptoms until it compresses the trachea or a bronchus sufficiently to cause partial obstruction of the air passage. Then wheezing may be noted. Pneumonia due to secondary infection beyond the narrowed portion of the tracheobronchial tree can occur.

The roentgen findings of mediastinal lymphatic cysts are not diagnostic. Usually a mass of uniform density with a rather sharply defined border is noted to project from the superior or anterior mediastinum. The multilocular type may show only a diffuse widening of the upper mediastinal shadow. The unilocular type is likely to project into the right hemithorax. Roent-

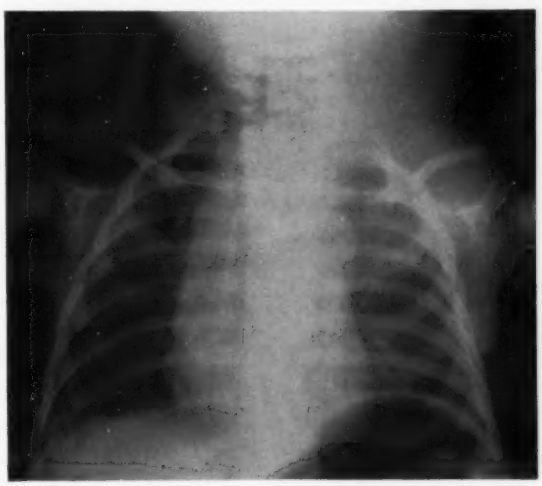

FIG. 1. Roentgenogram of child with a cervicomediastinal lymphangioma. Note widening of upper mediastinum and diffuse increase in density over left upper lung field produced by the overlying lymphangioma. There is also a large mass in the left cervical region.

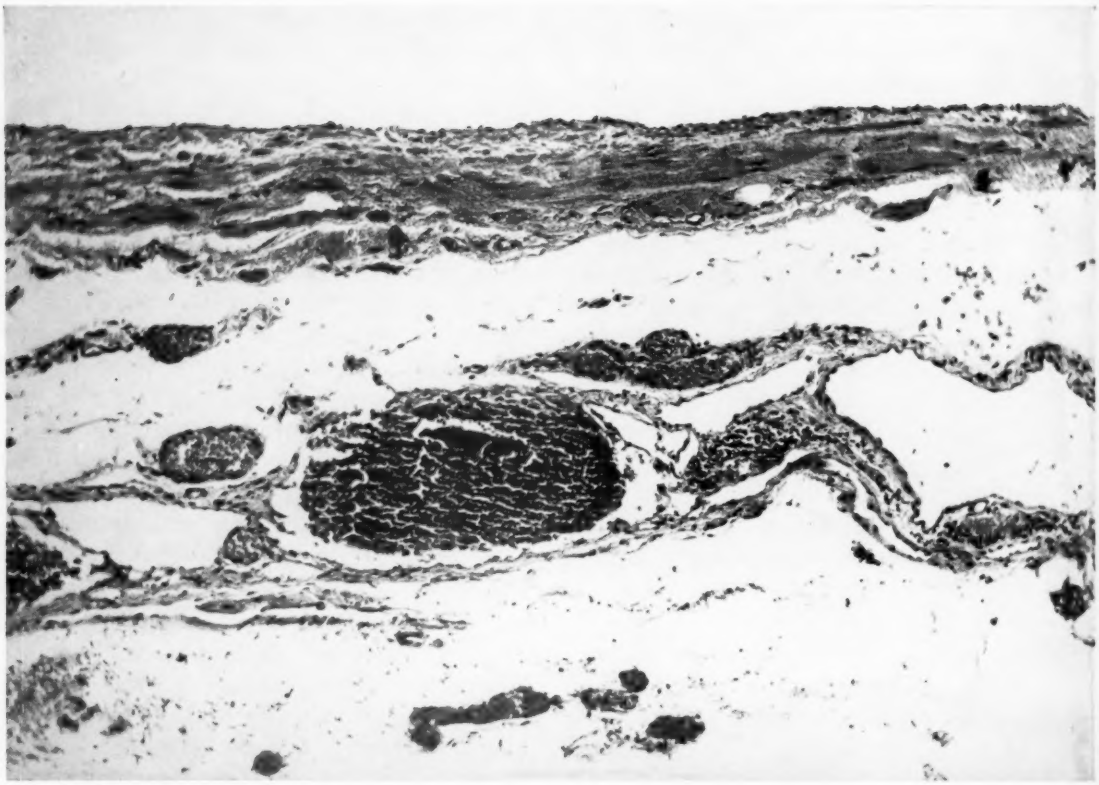

Fig. 2. This photomicrograph of the cyst from Case II shows the cyst wall to be lined by a single layer of cells resembling endothelium resting on a layer of connective tissue containing smooth muscle. There is a lymph follicle in continuity with dilated lymphatic vessels.

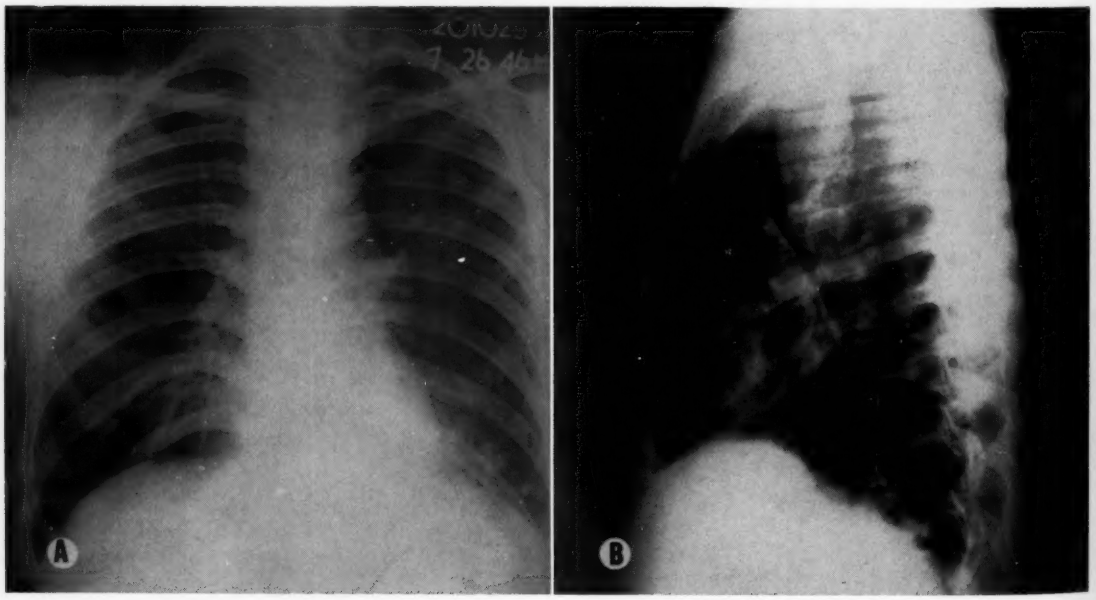

Fig. 3. Case I. (*A*) Roentgenogram in posteroanterior projection shows only slight widening of the mediastinal shadow at the clavicular level and some residual pneumonic infiltration at the left base. (*B*) The lateral roentgenogram shows the marked forward displacement and considerable narrowing of the trachea by the retrotracheal lymphangioma.

genologic features of lymphatic cysts are often similar to those of the more frequently encountered bronchiogenic cysts of the mediastinum. The location of bronchiogenic cysts, however, is more variable.[5] The roentgenographic appearance of intrathoracic lymphangiomas can readily simulate mediastinal lymphosarcoma or Hodgkin's disease. The differentiation of these lesions is most important because of the very different prognosis. Exploratory thoracotomy is often indicated for diagnosis and possible therapy. At present it does not seem possible definitely to diagnose a lymphatic cyst of the mediastinum preoperatively when no cervical or thoracic wall component is present. If preoperative aspiration of a cyst in the anterior portion of the thorax is undertaken and clear watery fluid obtained, one is probably dealing with either a lymphatic cyst, a pericardial celomic cyst, or a serous cyst of undetermined derivation.

REPORT OF CASES

Case I. This thirteen year old boy had been considered to be asthmatic because of a wheezing type of respiration. No cervical mass was present. A bilateral bronchopneumonia developed. The roentgenogram taken at the bedside was interpreted as showing some paramediastinal pleuritis in addition to the patchy infiltration at the lung bases. It was only after a subsequent lateral film had been obtained that the marked forward displacement of the trachea by a mediastinal mass was recognized (Fig. 3). The esophagus was displaced to the right. Thoracotomy revealed a multilocular lymphangioma which lay behind the trachea and pushed it forward. The cystic mass was successfully removed.

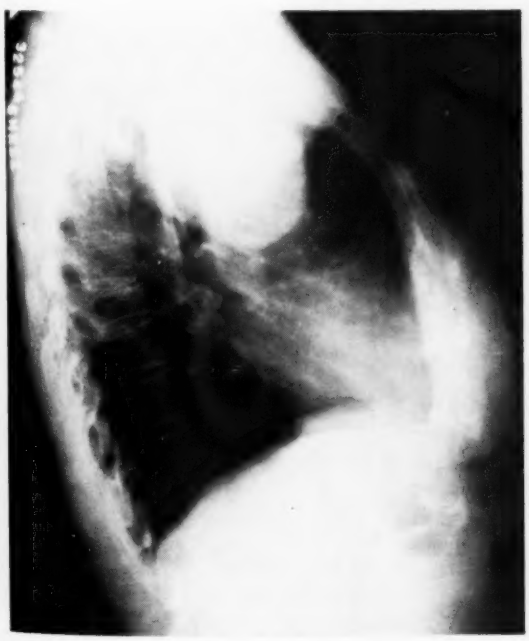

Fig. 4. Case II. This rounded mass which projected from the mediastinum was a unilocular cyst of lymphatic origin.

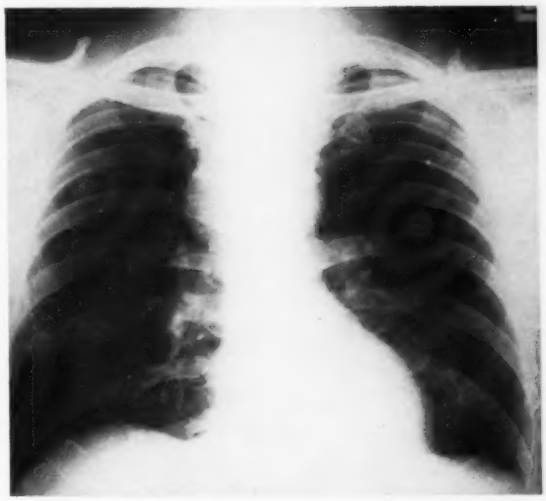

Fig. 5. Case III. There is a small lymphangioma protruding from the right side of the mediastinum opposite the aortic arch.

Case II. This fifty-four year old female complained of slight cough and very slight disturbance in breathing of two months' duration. Physical examination was essentially negative. An intrathoracic mass had been found on a roentgen examination two years previously. There had been some increase in the size of the mass in the two year period. The roentgenogram showed a rounded mass projecting from the right side of the upper mediastinum with slight tracheal compression (Fig. 4). At operation a large thin-walled unilocular cyst containing colorless fluid was found to project into the right pleural cavity. The vena cava was displaced anteriorly and the trachea slightly posteriorly and to the left. The cyst was removed intact. The postoperative course was uneventful.

Case III. This middle aged man had no symp-

toms but a survey roentgenogram had demonstrated a small mass projecting from the right side of the upper mediastinum (Fig. 5). At operation a small multilocular lymphatic cyst was found intimately associated with the mediastinal structures near the lower right side of the trachea and vena cava. It could not be removed intact but there was no roentgen evidence of recurrence a year later.

DISCUSSION

Several types of thin-walled cysts containing clear watery fluid may be encountered within the thorax. The most common is the pericardial celomic cyst, which is considered to result from faulty persistence of recesses of the pericardial celom.[2] These cysts are usually found adjacent to the pericardium in the cardiophrenic angles and rarely in association with the upper portion of the pericardium. The lymphatic cysts are usually located in the anterior or superior mediastinum. When a thin-walled sac containing colorless fluid is encountered in the costovertebral area, an intrathoracic meningocele may be present.[1] A number of additional cases of mediastinal cysts with clear fluid in which the gross and microscopic findings have not permitted classification with either the pericardial or lymphatic groups, have been designated as serous or "spring-water" cysts. Hydatid cysts in the mediastinum have not been included in this discussion. Also bronchiogenic, dermoid and reduplication cysts which do not contain a clear watery fluid are not in the scope of this paper.

Although a lymphatic cyst was considered in the preoperative differential diagnosis of Case 1, it was erroneously assumed that an extremely thin-walled cyst could not displace the trachea forward to such a marked degree without more bulging of the cyst laterally from the mediastinum. The posteroanterior roentgenogram had not shown sufficient widening of the mediastinal shadow even to suggest the presence of a mediastinal tumor. The probable explanation of the findings lies in the tendency of lymphatic cysts to be intimately connected with adjacent structures and thus they can cause a degree of compression out of proportion to the size and flexibility of the mass.

Cases of mediastinal lymphatic cysts apparently have a wider age distribution at the time of diagnosis than cervical hygromas which are usually recognized in infancy or childhood. In general, a grossly unilocular cyst is more likely to be found in the older patient whereas those masses which consist of innumerable small lymphatic cysts are usually clinically manifest in childhood. It would seem therefore that the grossly unilocular cyst may attain a given size more slowly than the multilocular mass. An important exception to this statement occurs when rapid enlargement of either type results from adjacent infection with lymphatic irritation.

Lymphatic cysts should be removed surgically unless there is a contraindication to operation. Radiotherapy, although advocated by a few for the treatment of cervical hygromas, is not recommended. Intense radiation therapy may fail to influence an intrathoracic lymphatic cyst.

SUMMARY

Lymphatic cysts are among the rarer cystic lesions of the mediastinum. A downward intrathoracic extension of cervical cystic hygromas occasionally occurs. Rarely the lymphangioma is entirely within the thorax. Such cysts can roentgenographically simulate other mediastinal lesions. The clinical, roentgen, and pathologic features of such intrathoracic lymphangiomas are presented.

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Vol. 73, No. 1

CALCIFIED INTRACRANIAL TUBERCULOMA

WITH REPORT OF A CASE

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TUBERCULOUS infection of the nervous system occurs as tuberculous meningitis and tuberculoma. Tuberculous meningitis is not an uncommon condition, but intracranial tuberculoma is less common and calcified intracranial tuberculoma is indeed rare. Scott and Graves,[9] in 1933, collected 815 cases of tuberculoma of the brain reported since 1790. They found that tuberculoma constituted 2.5 per cent of brain tumors. Only 11 of their 815 tuberculomas were calcified. In 1927 Van Wagenen[10] reviewed 1,000 cases of verified brain tumor at the Peter Bent Brigham Hospital, Boston. He reported an incidence of tuberculoma of 1.4 per cent. He pointed out that these lesions occurred four times more frequently in persons under nineteen years of age than in those over this age. In Evans and Courville's[5] series of 15,000 routine autopsies, there were 43 tuberculomas of the brain; 3 of these, or about 7 per cent of the tuberculomas, were calcified. Weinberger and Grant[12] report only 1 case of calcified tuberculoma in over 1,400 cases of verified brain tumors.

SYMPTOMATOLOGY

The symptomatology of tuberculoma, like that of brain tumor in general, varies with localization. There is a predilection of the lesion for the cortex of the cerebrum and cerebellum, possibly because of the greater vascularity of these sites and the hematogenous origin of the lesion. Solitary lesions occur almost twice as frequently as multiple lesions and appear with almost equal frequency in cerebrum and cerebellum.[9] Multiple lesions are usually limited to two or three but may number as high as eleven.[11] Since tuberculoma is a necrotizing lesion, rather than a proliferative one, intracranial hypertension is often not a striking feature.[2] General symptoms of fever, leukopenia, lymphocytosis and systemic tuberculosis are usually not helpful in the diagnosis.[7] The course is chronic and the mortality high.

ROENTGENOLOGICAL FEATURES

Because of the tendency of tuberculomas to be cortical, the roentgen localization of calcified tuberculomas is frequently near the inner table of the skull. The size of the lesion, however, cannot be accurately determined from the dimensions of the areas of calcification. The centers of the larger calcified lesions are often radiolucent. The periphery of large and small lesions tends to be irregularly oval and a characteristic fine lace-like pattern has been described.[11,12] Frequently there is fragmentation and distortion of the calcium shell from contraction of the fibrous tissue capsule. Calcifications in angiomas and craniopharyngiomas may present diagnostic difficulties. Calcified gliomas seldom occur in children. The calcifications of tuberous sclerosis are usually discrete and smooth in outline, and the clinical picture of adenoma sebaceum and mental retardation is fairly typical. Scattered minute calcifications occur also with toxoplasmosis. Pancoast *et al.*[8] noted calcifications in 10 per cent of their series of brain tumors. They stated that they had not seen calcification in any of the cerebellar tumors but did find it in other lesions of the posterior fossa. Calcifications in the posterior fossa, therefore, strongly suggest that the lesion is not a brain tumor and tuberculoma must be carefully considered as a diagnostic possibility.

TREATMENT

The poor results experienced by Cushing[4] and Bailey[2] following surgical excision of

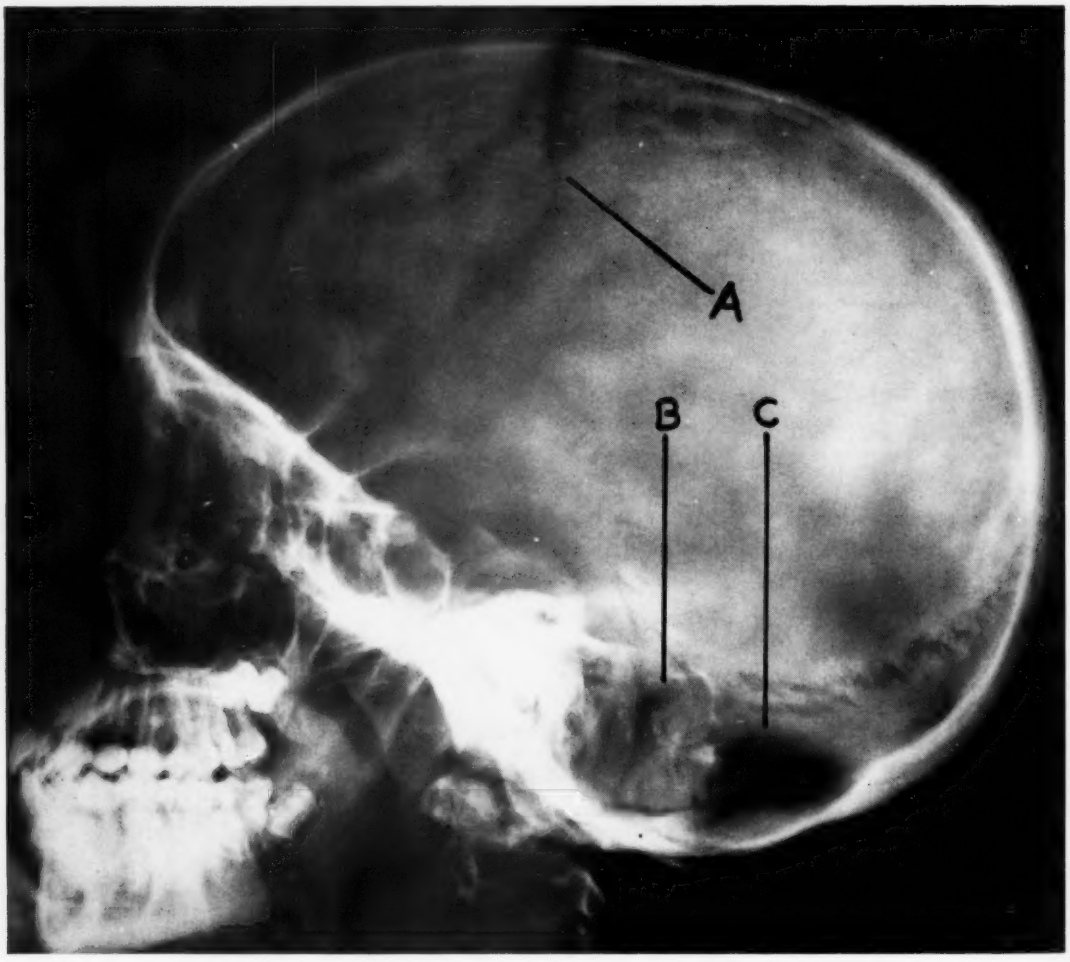

FIG. 1. Lateral roentgenogram of skull. (*A*) Separation of coronal suture. (*B*) Calcified density in left posterior fossa. (*C*) Thinning of left occipital bone.

tuberculomas led them to advise only decompressive procedures. Since the introduction of streptomycin, the hazard of tuberculous meningitis following surgery has been materially reduced; consequently, more favorable recent results have been obtained following excision of cerebral and cerebellar tuberculomas, even in the presence of disseminated systemic tuberculosis.[3] In a recent series[6] of 10 cases of intracranial tuberculoma, 7 were living and well twelve to thirty-six months following surgical extirpation of the lesions. Cerebellar lesions are generally more deeply seated and more difficult to extirpate than cerebral lesions.

CASE REPORT

J.M.H. (No. 86611). This colored male child was first seen at the Jackson Memorial Hospital on March 7, 1949, when nine years of age. He then presented a history of severe headache and some vomiting, with the onset of symptoms one week following "measles." He was admitted to the Pediatric Service. Examination revealed a very stiff neck and moderate lethargy without other significant neurological findings. The cerebrospinal fluid pressure was 300 mm. of H_2O, protein was 285 mg. per cent, and 9 cells per cu. mm. were present. The serological test for syphilis was negative. A diagnosis of measles encephalitis was made. His course was afebrile. He made a spontaneous recovery and was discharged from the hospital six days following admission.

This patient was next seen on the Neurosurgical Service 3½ years later, on August 21, 1952. Following his discharge from the hospital in 1949, he had apparently been asymptomatic until April, 1952. At this time he had had a febrile episode of several days, followed by a

generalized convulsion with urinary incontinence. Since that time he had had progressively more seizures affecting chiefly the right face and right upper and lower extremities. On admission he complained of frontal and occipital headaches, progressive episodes of mental confusion, and difficulty in walking. He had had an internal strabismus of the right eye for many years.

Examination revealed a preadolescent colored male who was obviously confused. He did not know the season or the year, repeatedly asked who brought him to the hospital, and was easily distracted when attempting to perform simple acts. The pupils reacted well to light and accommodation. The fundi were normal. The visual fields were intact to confrontation. In forward gaze, fixation was with the left eye, while the right eye turned directly upward. In lateral gaze there was no squint, but in upward gaze there was dissociation of the extraocular movements. Caloric tests revealed no response on the left, but there was apparently no deafness. There was no nystagmus and the other cranial nerve functions were intact. There was no weakness of the extremities. Pain, touch, position sense, vibration and stereognosis were intact. The deep tendon reflexes and plantar responses were normal. He stood on a broad base, swayed markedly and fell first to one side and then the other. The gait was very ataxic. Finger to nose and heel-knee-shin tests were poorly performed on the left but done well on the right. There was dysdiadokokinesis and dysmetria of the left upper extremity. The admitting impression was "mass lesion of left cerebellar hemisphere and a left cortical lesion as well."

Urinalysis was normal. There was an anemia of 9.7 gm. of hemoglobin. Lumbar puncture revealed normal spinal fluid pressure, 160 cells per cubic millimeter with 88 per cent mononuclears, protein 484 mg. per cent, sugar 33 mg. per cent, chlorides 670 mg. per cent, colloidal gold curve 001123331. The Mantoux intradermal test was negative. Roentgenograms of the skull revealed a calcified serpiginous or cochlear shaped density deep in the left posterior fossa. The coronal sutures were separated and there was thinning of the left occipital bone (Fig. 1 and 2). Routine chest films were normal.

On August 26, 1952, a left suboccipital craniectomy (I.P.) was made after ventricular estimation had revealed marked internal hydrocephalus. A large cystic and solid tumor occupied almost the entire left posterior fossa. A 2 mm. thick layer of softened, yellow cerebellar foliae covered this mass. A large cyst crossed the midline from the left and compressed almost the entire right cerebellar hemisphere anteriorly for approximately 1.5 cm. A solid tumor the size of a hen's egg was removed from the left posterior fossa, and several large cystic cavities were drained. The solid tumor was quite firm and tough and contained gritty particles in its depths. The tumor defect measured approximately 9 by 6 by 6 cm. The tumor was dissected cleanly from the tentorium but was found to extend superiorly through the incisura into the middle fossa. Inferiorly tumor extended through the foramen magnum, where it was intimately adherent to the medulla. Attempts at excision in this area caused sudden apnea on two occasions, and further attempts to completely remove the lesion were deemed inadvisable. The patient died two days later.

Fig. 2. Occipital roentgenogram of skull. (A) Calcified density in left posterior fossa.

Histopathological examination revealed that the tumor was a partially calcified tuberculoma (Fig. 3), but acid fast organisms were not found on the sections. The tumor had spread directly through the incisura of the tentorium and through the foramen magnum. There were other smaller tuberculomas; one in the left occipital pole, another in the left sylvian fissure. The cause of death was believed to be extensive bilateral pneumonia. There was also a spontaneous perforation of the esophagus with mediastinitis. Evidence of systemic tuberculosis was not found.

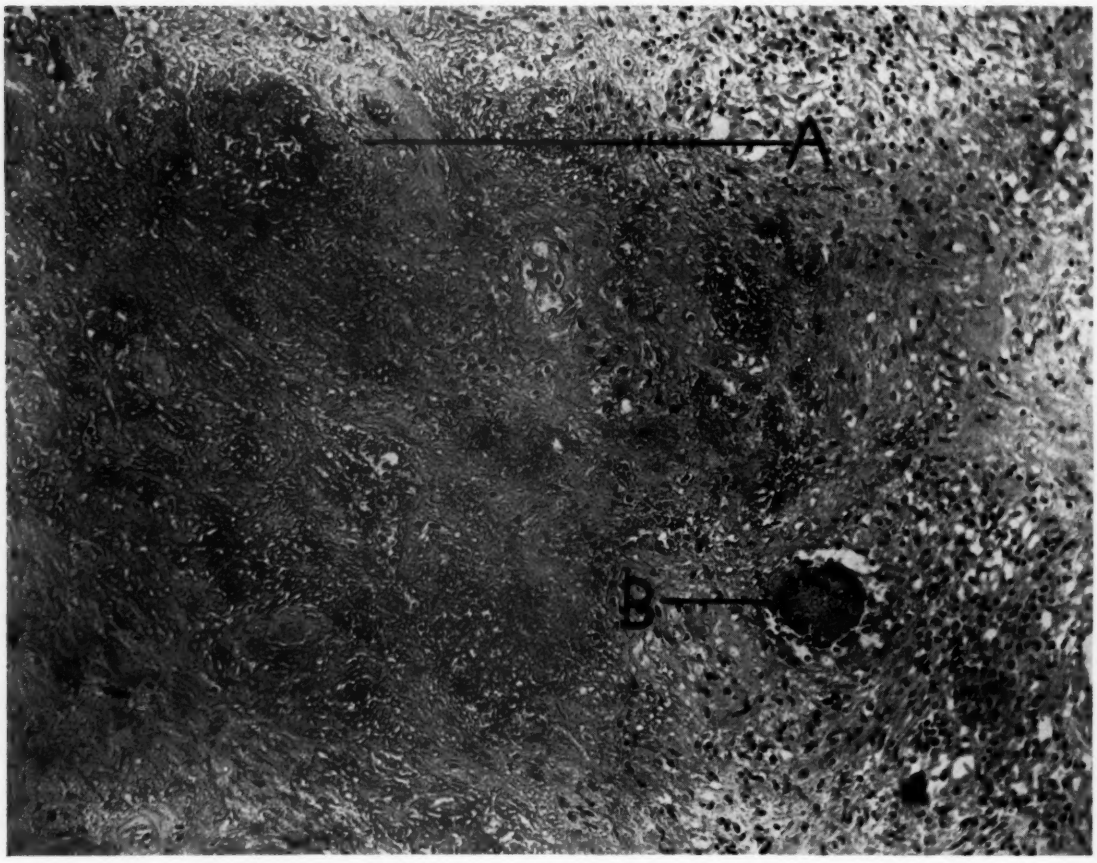

FIG. 3. Photomicrograph of tuberculoma. (*A*) Area of calcification and surrounding necrosis. (*B*) Multinucleated giant cell.

SUMMARY

Tuberculoma constitutes approximately 2 per cent of brain tumors. Calcification occurs in only 5 per cent of tuberculomas. A verified case of calcified tuberculoma of the posterior fossa is presented in its clinical, roentgenological and pathological aspects.

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LIPOID GRANULOMA OF BONE WITHOUT CRANIOHYPOPHYSEAL LOCALIZATION

REPORT OF CASE

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AS STATED by Snapper,[2] "diagnostic difficulties must arise when lipoid granulomatosis of the bones does not show the typical craniohypophyseal localization but is situated in the rest of the skeleton only. Under these circumstances the correct diagnosis is often missed. . . . This disease evidently is fairly frequent. It occurs less rarely than the typical Hand-Schüller-Christian disease but is usually not recognized and goes under different names."

This statement may possibly explain the fact that Leger, Ducroquet and Leger, after a thorough search of the literature, found a total of only 42 cases published up to 1949.

In view of this it may be of some interest to report the following case.

CASE REPORT

The patient, a boy aged fifteen, was first seen in March, 1950. He complained of pain in the region of his left ankle of five months' duration. Neither his family nor his personal history contained any valuable anamnestic data. The onset of pain was gradual, without any visible reason. It was slight at the beginning and reacted well to rest and heat therapy, but grew worse in time. Walking and even standing on the affected leg became very difficult. In addition to these symptoms a slight swelling appeared above the ankle joint in the course of the last few weeks preceding his admission to the hospital.

On examination there was a slight, ill defined, hard swelling on the anteromedial aspect of the distal part of the left tibia, just above the ankle joint. The skin, normal in appearance, did not show any adherence to the underlying structures. The local temperature did not differ from that of the surrounding area. There was no perceptible fluctuation. Deep pressure was painful.

Movements in the neighboring ankle joint were free but painful at the extreme range. There were no perceptible inguinal lymph nodes.

On general somatic examination no abnormal findings were discovered, except a generalized adiposity and a slight hypoplasia of the genital organs (Fig. 1).

FIG. 1. Photograph of the patient.

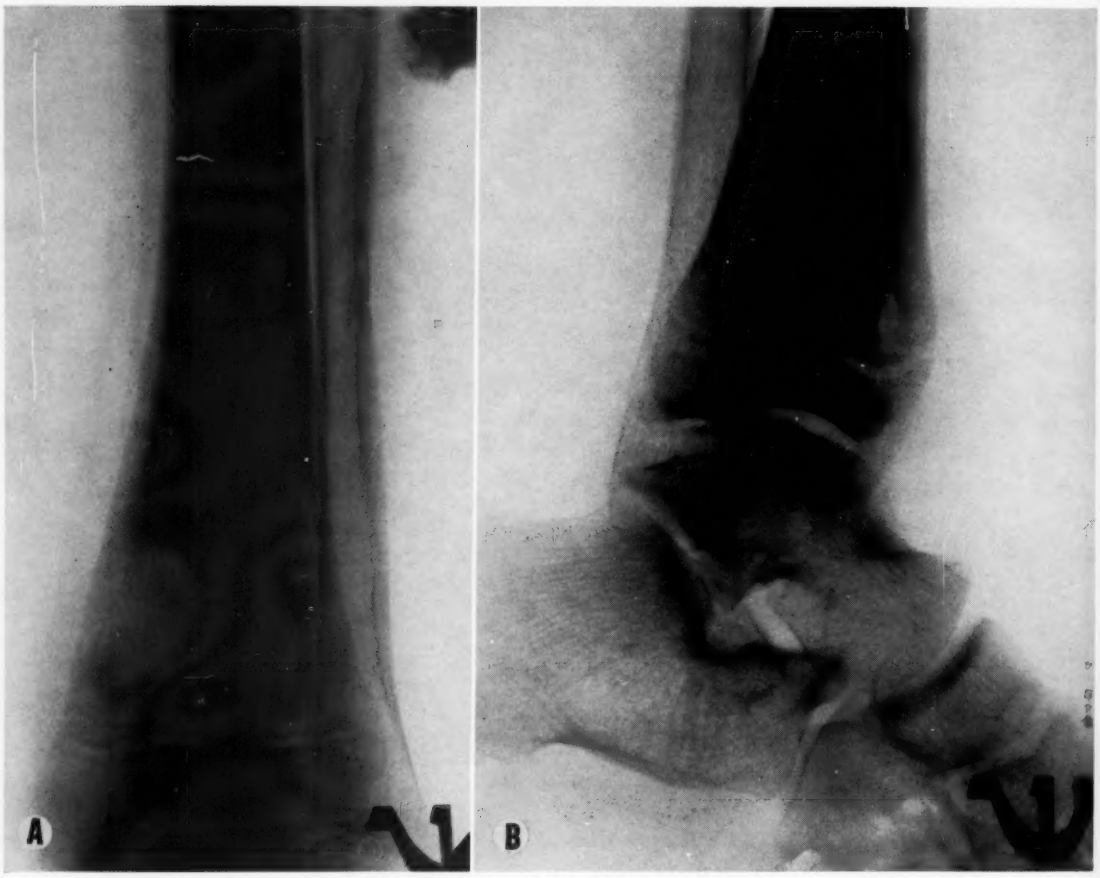

FIG. 2 (*A*) and (*B*) Roentgenograms of the left tibia showing pseudocystic lesion in the lower metaphysis (lesion producing local symptoms).

Roentgen examination of the affected area (Fig. 2) showed a pseudocystic lesion in the anterior part of the lower metaphysis of the tibia, extending to the very limit of the epiphyseal cartilage. In the anteroposterior view there was a thinning of the cortex and periosteal new bone formation on the medial border of the metaphysis.

The roentgen appearance of the skull was normal. The roentgen examination of all other bones of the skeleton disclosed only one small pseudocystic lesion in the upper posteromedial part of the diaphysis of the opposite (right) tibia.

Laboratory Examinations: Blood sedimentation rate: 1 hour, 20 mm.; 2 hours, 28 mm. Blood count: hemoglobin, 80 per cent; red blood cells, 4,750,000; white blood cells, 8,500; color index, 0.85; band forms 3 per cent, segmented forms 50 per cent, eosinophils 2 per cent, lymphocytes 40 per cent, monocytes 5 per cent. Blood chemistry: inorganic phosphorus, 7.7 mg. per cent; calcium, 9.6 mg. per cent; cholesterol, 140 mg. per cent; alkaline phosphatase, 3 U.B. Urine: nothing abnormal. A bone marrow smear taken from the ilium was normal in appearance.

At operation, the anteromedial aspect of the lower third of the left tibia was found slightly protruding but without any perceivable macroscopic changes of the cortex. The periosteum was obviously thickened, but could be easily separated from the underlying bone. A window was cut in the cortical bone in order to reach the cavity, which was found to be filled with a homogeneous, soft, yellow-grayish matter. There was no adherence between this soft tissue and the walls of the cavity. After the former had been taken out, the walls showed no irregularity and appeared to be covered with a smooth and glossy lining. The walls were curetted until healthy bone tissue appeared and the

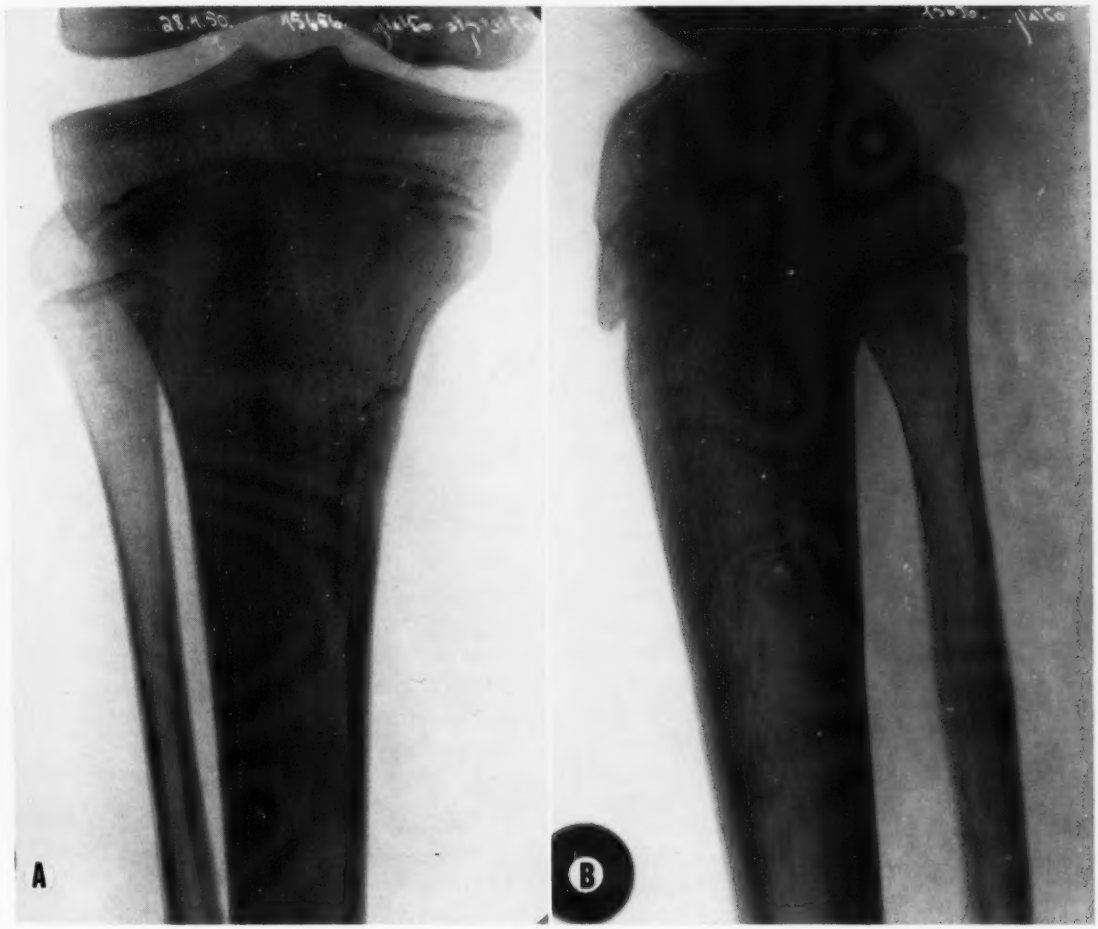

Fig. 3 (*A*) and (*B*) Roentgenograms of the right tibia of the same patient showing analogous lesion in the upper part of the diaphysis (lesion discovered on routine examination of the skeleton).

wound closed in layers.

The postoperative course was normal. The wound healed by first intention. The patient did not complain of any more pain in his left ankle. Walking was allowed four weeks after operation and was painless.

When seen two months later the boy was still symptomless and working in a shop. Re-

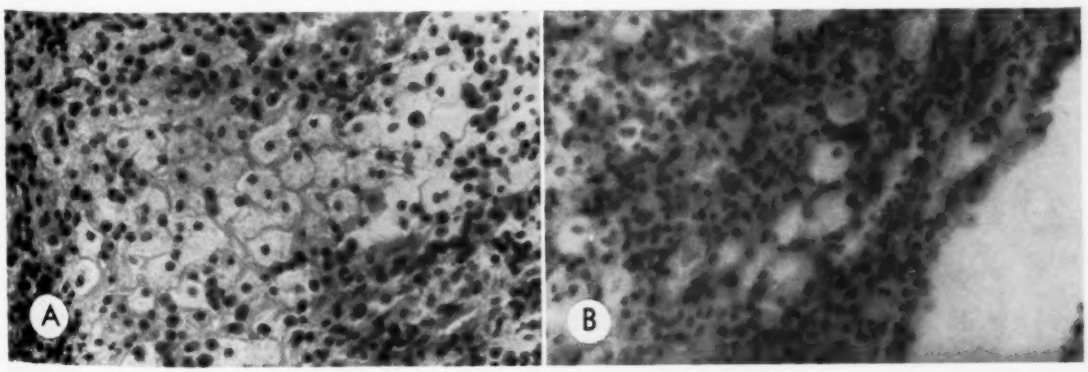

Fig. 4 (*A*) and (*B*) Microphotographs of the lipoid granuloma filling the pseudocystic cavity.

peated roentgenograms showed no change.

Bacteriological examination of the contents of the cavity showed no organisms and culture was sterile.

Histopathological examination (Fig. 4) of the yellow-grayish matter that filled the pseudocystic cavity showed it to be formed principally of nonspecific inflammatory granulation tissue, rich in vessels and neutrophils. In certain areas there was to be seen some fibrous granulation tissue containing islands of large polygonal or oval-shaped cells with small, round, chromatin-rich and centrally situated nuclei. These nuclei were surrounded by large, spongy looking protoplasm (foam cells). A few eosinophils were found. There were also some aberrant bone spicules in the midst of the granulation tissue.

The cancellous neighboring bone was in some places normal and in others showed replacement of the normal bone marrow by either fibrous tissue or granulation tissue containing the above mentioned foam cells.

Nothing abnormal was noted in the thickened periosteum except for some increase in collagenous fibers and poverty in cells.

Conclusion. Lipoid granuloma of the bone.

COMMENT

The diagnosis and classification of lipoid granulomatosis of bone without craniohypophyseal localization is based upon three main signs which are common to all cases: (1) a pseudocystic cavity of one or more bones with thinning of the cortex; (2) histopathologically the cavity is shown to be filled with granulomatous tissue containing islands of xanthomatous cells (foam cells); (3) absence of any craniohypophyseal signs of typical Hand-Schüller-Christian disease.

Other features are less constant. Local symptoms may or may not be present, in which case the lesions are discovered either accidentally on roentgenological examination or because of a pathological fracture.

In our case one lesion (left tibia) caused symptoms and the other was quite symptomless.

Blood chemistry is usually normal with the exception of hypercholesterolemia which was found by Leger, Ducroquet and Leger in 14 out of 22 cases where this investigation was carried out. In our case the blood cholesterol level was slightly below normal as in the 2 personal cases of the above mentioned authors.

On the other hand, the inorganic phosphorus content of the serum was raised in our case, as it was in the case of Fontaine and Gery (one of those reviewed by Leger *et al.*). There were no valuable etiological data in our case. The predominance of the male sex has been noted by Leger, Ducroquet and Leger just as it is in the Hand-Schüller-Christian syndrome.

The immediate good results following surgical removal of the xanthomatous granuloma—as in our case—are generally acknowledged. But in most of the cases the follow-up period has not been long enough to warrant the definitive good prognosis one would like to expect. One case showed no recurrence after ten years, but in another local recurrence was unmistakable six months after operation.

Reports of secondary sarcomatous degeneration have also been published (Snapper).

There is another feature in our case we would like to point out, namely the mild form of dystrophia adiposogenitalis this boy seems to present (Fig. 1). If we may presume to make conclusions from such meager evidence we would say that ours is a borderline case between the lipoid granulomatosis of bone without craniohypophyseal localization and Hand-Schüller-Christian disease.

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PANTOPAQUE PULMONARY EMBOLISM*

A COMPLICATION OF MYELOGRAPHY

By LEONARD B. GINSBURG, M.D.,† *and* ALAN B. SKORNECK, M.D.‡

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VENOUS intravasation with pulmonary embolism is a most unusual complication of myelography. Opaque contrast material has been in use for thirty years since its introduction by Sicard and Forestier,[5] yet only 3 cases of "disappearing pantopaque" or other contrast material have been reported in the English literature.[1,3] Of the 3 reported instances, embolization was visualized roentgenographically in only one.[6]

In view of the rarity of this complication, despite the great numbers of myelographic examinations being done, we believe it of interest to add a fourth case to the literature, the second in which pulmonary embolism occurred.

CASE REPORT

M.M., a fifty-four year old machinist, was admitted to the Newington Veterans Administration Hospital on October 2, 1952, with the complaint of back pain limited to the sacroiliac area. Eight months prior to admission he had had a spinal anesthetic for a herniorrhaphy. Two months later the sacroiliac pain began. It was at first mild, present only in the morning upon arising, wearing off as the day progressed. Gradually the severity and intensity of the pain became more prolonged so that at the time of admission it was constant. Four weeks before admission, the patient noticed that he was dragging his left foot.

Neurological examination revealed diminution of the vibratory sense over the lumbar spine and complete loss over the sacrum and lower limbs. The knee jerks were hyperactive and bilateral ankle clonus was present. The abdominal reflexes were sluggish. Repeated testing suggested a sensory deficiency to scratch at approximately D6–7.

Spinal puncture revealed the dynamics to be normal. The total proteins were slightly elevated to 65 mg. per cent. Blood study revealed a white cell count of 10,100 with a normal differential. The hemoglobin was 13.5 grams. Urinalysis was normal. The serology test for syphilis was negative.

Roentgenogram of the chest was normal (Fig. 1). Films of the lumbar spine demonstrated an old compression fracture of the anterior superior plate of L3.

On October 28, 1952, myelography was performed. A small amount of pantopaque was injected into the subarachnoid space between L2–3 after clear spinal fluid had been obtained. When this was roentgenoscopically observed to be free flowing an additional 2 cc. was added and again observed roentgenoscopically. This time the movement of the oil seemed sluggish and the tip of the needle was advanced slightly to make sure it was well within the subarachnoid space. When the stylet was withdrawn, to add an additional 3 cc. of oil, fresh blood was noted. The needle was withdrawn slightly, blood-tinged spinal fluid now appearing. Feeling that the needle was in proper location, the 3 cc. of pantopaque was injected. On roentgenoscopic recheck, however, this additional quantity was not visualized. Not realizing the cause of failure of visualization, an additional 6 cc. was injected despite the "trickling away of the first few drops" roentgenoscopically observed. During the procedure the patient experienced no unusual sensations. One of the authors (L. B. G.) was then called in by the resident performing the examination. At this time approximately 2 cc. of oil remained in the lumbar subarachnoid space despite a total injection of 12 cc. of contrast material. A film survey of the entire sub-

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Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are a result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

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FIG. 1. Normal admission chest film September 24, 1952.

arachnoid pathways and chest failed to reveal any trace of the main portion of the injected material. Anteroposterior and cross table lateral films of the spine at the level of the injection were also made. These showed the tip of the needle together with numerous oil droplets within the body of L3 (Fig. 2 and 3). The small remaining quantity of oil was not aspirated. The stylet of the spinal needle was again removed, before the needle was withdrawn, and grossly sanguineous fluid welled forth.

The patient was returned to the ward in a sitting position. He was entirely asymptomatic. The ward physician was notified of the inadvertent intravenous pantopaque injection and cautioned of the possibility of pulmonary embolism.

That evening the patient experienced a severe shaking chill. His temperature rose to 102.4° F. Physical examination revealed no significant abnormal findings. There was no chest pain, cough or dyspnea. Roentgenographic re-examination of the chest the next morning revealed numerous small, nodular, fuzzy infiltrations in both lower lung fields (Fig. 4) more pronounced on the left. The following day the patient coughed up some scanty blood-tinged sputum on one occasion. He complained of moderate

FIG. 2. The needle tip is shown in the body of L3. Small droplets of oil are seen in the basivertebral veins.

FIG. 3. Horizontal lateral film taken just after Figure 2. and showing the needle within the body of L3 and oil droplets in the basivertebral veins.

diffuse pain in the occipitocervical region. A repeat chest film, however, revealed complete disappearance of the previously noted infiltrations. The elevated temperature returned to normal in two days. There was no change in the white blood cell count during the febrile episode. A sample of pooled twenty-four hour urine tested by the State Laboratory was reported as showing no increase in iodine or iodides.

A week following myelography, the patient was completely asymptomatic except for his original complaint of low back pain.

DISCUSSION

There is an extremely rich venous network of vertebral veins (Fig. 6). The internal plexuses communicate eventually with the inferior vena cava via the lumbar and lateral sacral veins.[2] In view of this anatomical fact it is surprising that in the course of lumbar puncture for myelography, intravasation of diagnostic opaque fluid is not more frequent. If a vessel is nicked or torn by the needle, the higher pressure in the subarachnoid space contrasted to that of the venous network would tend to force the oil into the venous pathways.

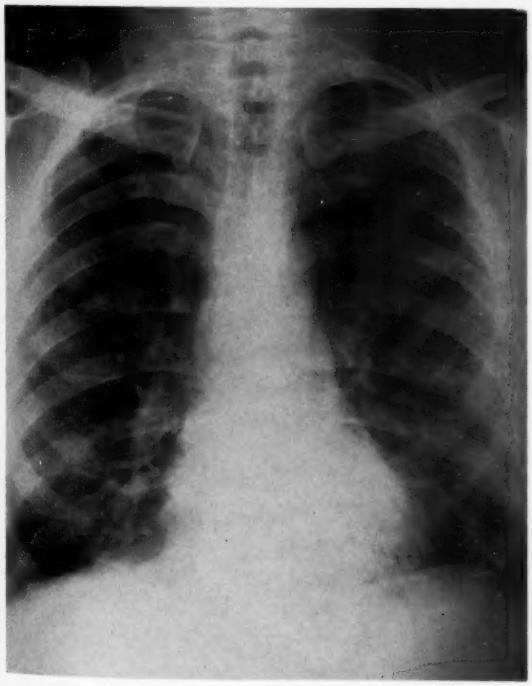

Fig. 4. Small nodular densities in the basilar portions of the left lower lobe representing pulmonary emboli.

Fig. 5. Enlargement of Figure 4.

The unusual feature of the case presented was the demonstration of direct injection of oil into the basivertebral vein of L_3 (Fig. 3). The previously reported instances were the result of indirect entry of the pantopaque into the venous system. Hinkel[3] described a case in which the pantopaque was noted to be in one column at the start of the examination. To determine the subarachnoid location of the oil, the patient was asked to cough. With the cough, the opaque material "appeared to extend in all directions like a star-burst. The original subarachnoid oil column shrank rapidly and branching, slender finger-like columns of oil were extending to the right, the left, caudad and cephalad from it. Within fifteen seconds no oil could be seen in the subarachnoid space . . . ." Steinbach and Hill[6] carried out myelography without incident following subarachnoid injection of 9 cc. of pantopaque. On

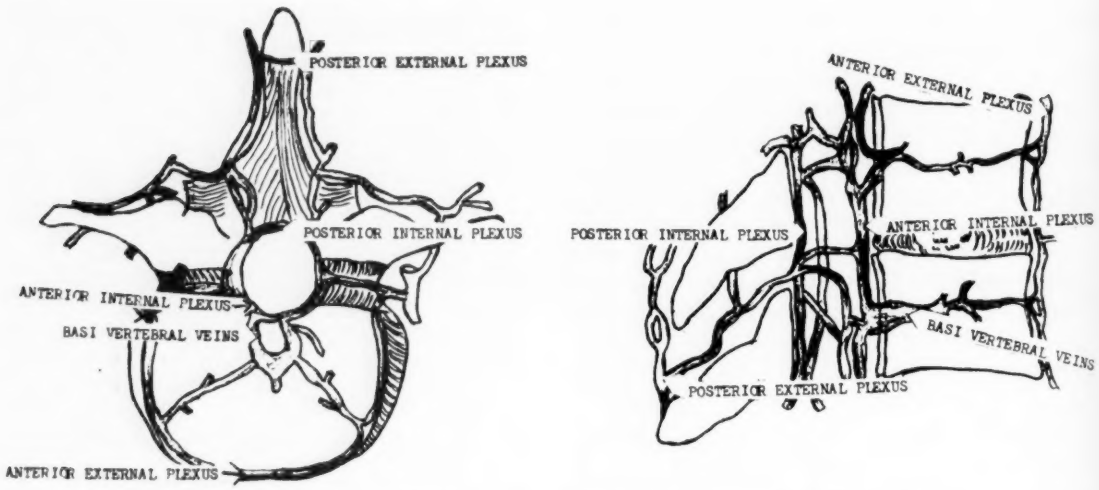

FIG. 6. Diagrammatic sketch of the extremely rich venous network of veins around the subarachnoid space.

attempted aspiration at the termination of the procedure, bloody fluid was obtained indicating injury to a vein. The needle was removed, another interspace entered, 1.5 cc. of oil and bloody fluid obtained. The examination was apparently terminated at this point, 7.5 cc. of oil remaining. Two days later roentgenograms of the chest revealed "multiple small, fine, reticular densities which appeared to lie chiefly anteriorly." The 7.5 cc. of pantopaque evidently disappeared from the subarachnoid space, since Steinbach says in his discussion, "Our patient received an estimated 7.5 cc. which cast a definite shadow in the lungs." The pulmonary findings persisted until time of discharge six days later. The mode of disappearance in Fullenlove's[1] case is not fully described, but undoubtedly was similar to that of the two previous instances.

The roentgenographic changes in the lungs of our patient were of short duration, disappearing in twenty-four hours. It is presumed that numerous capillaries were plugged with oil droplets causing focal edema and hyperemia. Strain[7] reports that in dogs weighing 34 to 44 pounds, slow injection of 8 cc. of pantopaque intravenously produced no serious results. Rapid injection caused death. No mention was made of any pulmonary roentgenographic changes. Sicard and Forestier[5] observed extremely transient lung densities lasting only six to eight minutes following slow intravenous injection of lipiodol into human subjects.

The relatively small quantity of opaque material and slow injection into the circulation results in considerable dispersion of the oil droplets in the blood. This probably accounts for the subsequent appearance of fine patchy infiltrations, rather than large focal areas of lung infarction. We believe that the variability in duration of the pulmonary infiltrations depends upon the development of superimposed pneumonitis.

SUMMARY AND CONCLUSIONS

A case of direct injection of pantopaque into the basivertebral veins with transient pulmonary embolism is described. This is the fourth case of inadvertent venous intravasation, the first of direct venous injection, the second with pulmonary roentgenographic signs of embolism.

In the presence of a bloody spinal tap, it is probably wise to discontinue the examination for at least several days in order to prevent the possibility of direct or indirect entrance of opaque material into the venous system.

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MYELOGRAPHIC DEMONSTRATION OF THE BASILAR ARTERY*

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VERTEBRAL artery angiography is a well established method for diagnosis of intracranial lesions. This is particularly true in aneurysms of the posterior portions of the circle of Willis. We are presenting another method of visualization of the upper vertebral and the basilar arteries. This method has not previously been described in the literature, although Malis *et al.*[2] have mentioned a demonstration of the basilar artery as an incidental finding in the myelographic diagnosis of the Arnold-Chiari malformation.

Four to 6 cubic centimeters of pantopaque are introduced into the lumbar subarachnoid space by the usual procedure for myelography. The head of the roentgenoscopic table is then lowered 45°, the patient's head being hyperextended by an

FIG. 1. Filling defect in pantopaque column produced by distal vertebral arteries and basilar artery.

FIG. 2. Myelographic demonstration of distal vertebral arteries and basilar artery.

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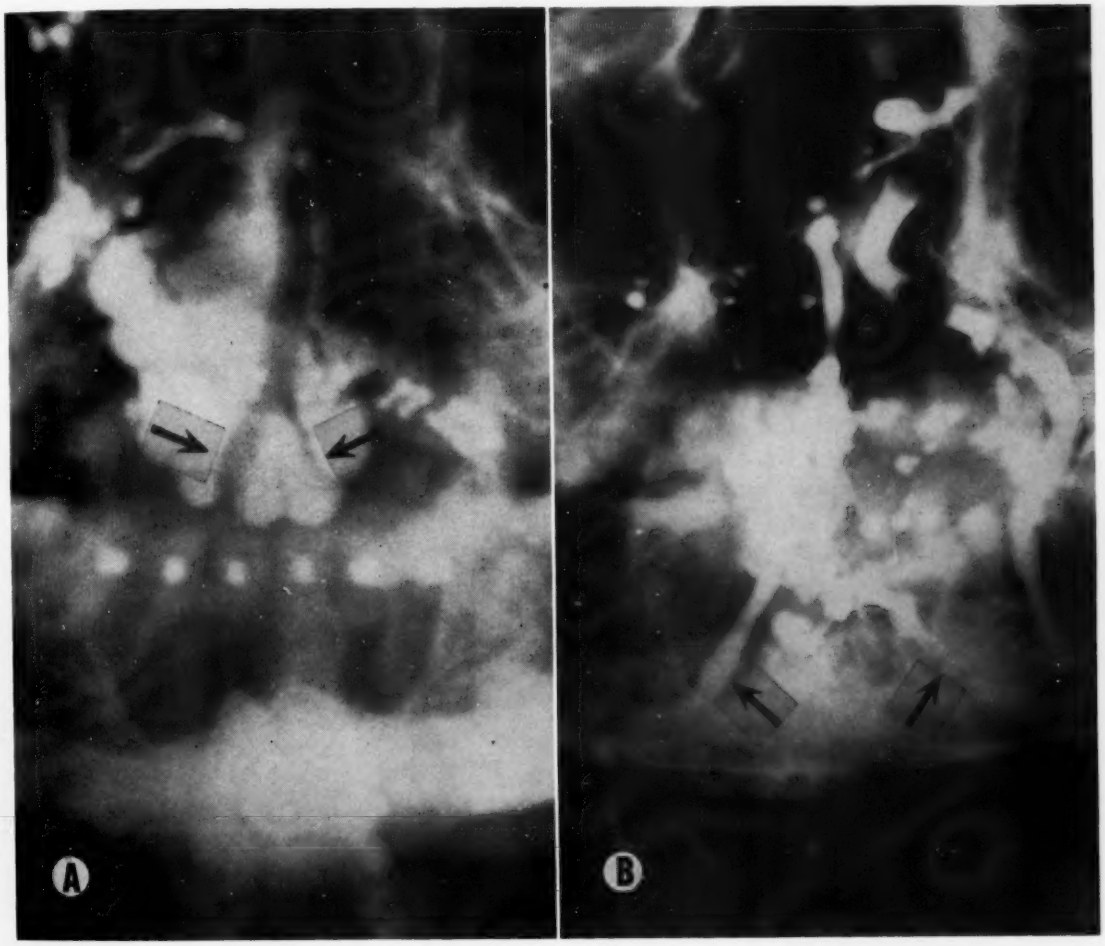

Fig. 3. (*A*) Postmortem myelogram demonstrating vertebral arteries and basilar artery. (*B*) Postmortem arteriogram of same patient, confirming the inequality in size of the two vertebral arteries.

assistant to allow the pantopaque to pool in the upper cervical region. A cassette is moved into place to take a spot film. The assistant then momentarily flexes the patient's head, a spot film is taken, and the head is immediately hyperextended. With a little practice and good cooperation between the assistant and the roentgenoscopist, a demonstration of the upper vertebral and basilar arteries can be obtained routinely. Very little, if any, oil escapes into the basal cisterns.

Anatomically, the vertebral arteries penetrate the dura to enter the cranial cavity just above the foramen magnum. The anterior spinal and posterior inferior cerebellar arteries are given off within the dura, The vertebral artery then joins with its fellow of the opposite side, forming the basilar artery at the level of the lower portion of the pons opposite the basisphenoid. Bilateral branches are given off by the basilar artery. These include the anterior inferior cerebellar artery, the pontine arteries, the superior cerebellar arteries and the terminal branches—the posterior cerebral arteries.

Figure 1 shows the upper centimeter of both vertebral arteries and the full length of the basilar artery producing a filling defect in the opaque column in a fifty-one year old female who was believed to have a normal cervical myelogram. Figure 2 is a similar view of the basilar artery in a

normal forty-eight year old male. The tortuosity of the basilar artery in this patient is well demonstrated. A filling defect produced by an artery, probably the anterior inferior cerebellar, is demonstrated on the right (arrow). Figures *3A* and *3B* are reproductions of films of a postmortem myelogram and vertebral arteriogram respectively. The myelogram shows an inequality in the diameter of the two vertebral arteries which is confirmed by the arteriogram. Retrograde filling of the left internal carotid artery occurred on the arteriogram. We have found that it is possible to visualize the basilar artery by myelography routinely in fresh cadavers.

We believe that this method of visualizing the basilar artery may be of value in the occasional case where vertebral arteriography is unsuccessful or is contraindicated. The method may also be used by those not familiar with the technique of vertebral arteriography, since it can be performed by anyone who does myelography.

SUMMARY

A myelographic method for demonstrating the basilar artery is presented. The method may have some advantage over the arteriographic demonstration of this artery in the occasional case.

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FURTHER OBSERVATIONS ON TISSUE DOSAGE IN CANCER OF THE CERVIX UTERI*

By MANUEL GARCIA, M.D.

NEW ORLEANS, LOUISIANA

THE correlation of therapeutic results and the radiation dose employed in the treatment of cancer of the cervix uteri, first undertaken in a study presented ten years ago,[1] is continued in this report with the analysis of 943 primary cases handled in our service during the six year period ending September 30, 1947.

Correlation can be derived most clearly from fully treated cases, eliminating as many extraneous influences as possible. The recovery rates so obtained will prove misleading unless it is understood that they apply in selected material only. In order to avoid misunderstanding, the total results and the degree of selection are indicated in the first two tables. Table 1 gives the five year results in accordance with the rules of the International Committee.[3] All cases have histopathologic verification; carcinoma in situ is excluded. Both relative salvage and absolute survival rates are shown; since the differences between the two are negligible, and the latter are more objective, only survival rates will be given in all subsequent tables. The failures from reactivation of the disease within the pelvis will not be distinguished from those due to metastases in untreated areas because distant spread is almost invariably associated with active disease in the pelvis; the exceptions are too infrequent to merit separate consideration, especially since we have a balancing influence in the rare cases that recover following supplementary irradiation for recurrence.

TABLE I

CANCER OF THE CERVIX: HISTOPATHOLOGICALLY VERIFIED PRIMARY CASES, CHARITY HOSPITAL OF LOUISIANA AT NEW ORLEANS, OCTOBER, 1941 THROUGH SEPTEMBER, 1947

Five year results

	Stage*				Total	Incidence
	I	II	III	IV		
Patients examined	110	227	508	98	943	100%
Not treated	1	5†	7†‡	11	24	2.5
Treated	109	222	501	87	919	97.5
Stage distribution	11.9%	24.2%	54.5%	9.5%	100%	
Untraced	0	1	1	1	3	0.3
Died of intercurrent disease	3	4	11	0	18	1.9
Died of cancer or cause unknown	27	108	353	81	569	60.4
Alive with cancer	2	1	5	1	9	1.0
Alive and well	77	108	131	4	320	33.9
Relative salvage	71%	49%	26%	5%	35%	
Absolute survival	72%	48%	27%	5%	35%	

* League of Nations Classification, 1937 Revision.
† One patient recovered after treatment elsewhere.
‡ One case untraced.

* From the Department of Radiology, the Charity Hospital of Louisiana at New Orleans, and the Department of Medicine, Tulane University of Louisiana School of Medicine. Presented at the Thirty-Fifth Annual Meeting, American Radium Society, St. Louis, Mo., April 20–22, 1953.

TABLE II

CANCER OF THE CERVIX, 1941–1947, TREATMENT CLASSIFICATION

	No. of Cases	Incidence	Survival Rate
Inadequate	24	2.5%	8%
Palliative	122	12.9%	1%
Atypical	75	8.0%	40%
Complete	703	74.5%	42%
Intercurrent deaths and untraced	19	2.1%	—
	943	100 %	35%

The manner of selection may be gauged from the groups displayed in Table II. The following cases are considered unsuitable for this study: 24 that refused part or all of their treatment; 122 with advanced lesions or serious complications that permitted palliation only, or prevented the administration of treatment; and 75 wherein the treatment was atypical. The last group includes 29 patients who had transvaginal irradiation in place of radium application, 12 who had had some radiation therapy elsewhere just prior to admission, 25 who had accidental or "prophylactic" hysterectomy, and 9 with carcinoma complicated by pregnancy. In addition, 19 fully treated cases are deleted because death was due to intercurrent disease or because they remain untraced. The balance, 703 cases, constituting 75 per cent of the material, received complete treatment and will be given fuller consideration.

The completely treated cases do not represent homogeneous material. They contain four subgroups with striking differences in survival rate (Table III). These, together with the age of the patients and the stage of the disease, will be considered below. To demonstrate more clearly the influence of the apparent extent of anatomic involvement, the Stage III cases have been subdivided according to invasion of the pelvic wall, whether unilateral (Stage III_A) or bilateral (Stage III_B). Racial differences have been discussed elsewhere;[2] the method of analysis largely eliminates their characteristic effects. Several other clinical and biologic factors affect the course of the disease, or its response to treatment, but attention will be restricted to the few with decisive prognostic significance.

In evaluating dosage for cancer therapy the goal, of course, is to determine the range where greatest tissue selectivity occurs. Best dosage is that which produces tumor healing in the largest proportion of cases without precipitating an unduly high incidence of injuries. Risk of injury must be accepted to achieve success, since the low dosage required for the prevention of all adverse effects obviously would sacrifice important benefits in the majority of patients. However, measurement of the hazard meets with some difficulty. Radiation injuries vary in severity, demanding stipulation of their degree, they must be distinguished from similar lesions associated with residual or recurrent neoplasm, or with infection, and their genesis is not exclusively related to the magnitude of the dose. Under the circumstances, the appraisal of dosage in the light of the rates of injury provoked leads to a rather complex method of analysis. Simplicity can be gained without ignoring the essence of the question by using a different approach. It will become evident from the tabulations to be presented that survival for five years is itself a valid test for assessing normal tissue tolerance. With the higher tissue

TABLE III

CANCER OF THE CERVIX; SUBGROUPS IN COMPLETELY TREATED CASES

	No. of Cases	Survival Rate
Uncomplicated	497	45%
Adenocarcinoma	44	27%
Infected	111	27%
Stump lesions	51	67%
TOTAL	703	42%

Table IV

TABULATION OF ROENTGEN IRRADIATION TECHNIQUES; 50 CM. FOCAL DISEASE

Symbol	Half-Value Layer in mm. Cu	Area of Fields		No. of Treatments	Duration in Weeks	Average Parametrial Dose, r
		Ant. and Post.	Lat.			
d	5	150	150	30	5	3,000
f	4	80	150	30	5	3,800
g	5	60	150	24–30	4–5	4,400
h	5	50	100	15	3	2,900
j	2.8	100	100	24	4	2,900
l	5	50	100	30	5	3,250

Accessory fields: perineal, juxtapudendal (50 cm.²).
Separation of fields in midline 2–6 cm.

doses to be discussed, 13.3 per cent of the patients exhibited complications of clinical significance (fistula, bowel obstruction, cervical and cutaneous necrosis, femoral fracture, etc.), whereas the moderate dosage given since 1945 has produced untoward sequels in 6.5 per cent, and at the same time higher survival rates. Improved results, therefore, need not be attained by inflicting more damage. It follows that optimal dosage will be objectively defined if maximum survival is used as the sole criterion of efficacy.

As in the previous report, the dose from roentgen and gamma rays received by each patient has been calculated at points A and B as defined by Tod and Meredith,[7] and located respectively at 2 and 5 cm. from the midline on a transverse axis 2 cm. above the vaginal fornices. The dose at point A will be called the paracervical dose, that at point B the parametrial dose. It must be conceded that the statement of dosage at two points can hardly be considered an adequate description of the energy gradients in the pelvis. Ideally a three dimensional study of the radiation distribution should be available in each case. But to make the analysis feasible one must accept a compromise with completeness. The points of dosage assessment were wisely chosen by the originators of the idea, and, as before, will be shown to have great utility.

Because the limits of infiltration in the pelvis cannot be measured ordinarily, an estimation of minimum tumor dose is not possible. The paracervical dose must serve instead as an indicator of the dose received by the primary tumor. The parametrial dose gauges the dose received by the more peripheral areas of possible tumor invasion, at the edge of the parametrium and approximately at the pelvic nodes. It may also be considered a guide to the tolerance of the entire block of tissue subjected to heavy dosage.

Technique. Of the 703 fully treated cases, 75 had radium therapy only, supplemented in a few instances by transvaginal roentgen irradiation; the rest received both external roentgen irradiation and radium therapy. In 124 patients the radium was given first, while in all the others the sequence was reversed. Roentgen and gamma ray dosage was precalculated throughout the period under study. The roentgen therapy techniques employed are described in Table IV. Six fields were used in the majority of cases: two anterior, two posterior and two lateral, directed perpendicularly to cross-fire the parametrial edge, 5 cm. from the midline, where the dose was assessed. In order to avoid irradiation of the cervix, as well as of the rectum and bladder, the central separation of the fields was 4–6 cm. with the techniques delivering higher dosage. In the majority two radium applications were employed, each 47–50 hours long, distributed over five or six days. Two or three radium tubes of French design with 40–45 mg., filtration 1.5 mm. Pt, were placed in

tandem in the cervical canal and lower uterine segment, and the same type tubes in a Kaplan colpostat, with or without accessory corks, were packed in the vaginal vault. The total quantity of radium in each application was 65–85 mg. The paracervical dose was 6,600 gamma roentgens ± 10 per cent. A single radium application lasting 50–58 hours and delivering 4,700 r_γ to the paracervical region was given in conjunction with technique "g." In a few bulky tumors, in some lesions of the stump, and in instances of cervical occlusion, a cylindrical interstitial implant was used in place of an intracervical source. In some lesions of the stump only vaginal sources could be employed. In a few aged women vaginal stenosis allowed the application of an intracervical focus only. The development of other complications and the lack of cooperation on the part of some patients introduced fluctuations in the time distribution of the treatment, and additional minor variations in technique. But these changes are reflected in the total dose in relation to the time, consequently it is not necessary to describe them.

As is well known, in order to elicit equal biologic effects equal amounts of radiation must be given in equal times. It is less frequently emphasized that the volume distribution and the energy of the radiation must also be equal. The dose of radiation thus has four "dimensions,"—quantity, quality, distribution in time, and distribution in space. In clinical radiation practice all four elements ordinarily vary by necessity, or by choice, and as a consequence comparison of the number of roentgens administered to each of a group of patients has little meaning in evaluating dosage. The problem, therefore, becomes one of finding a method whereby the variation in all four magnitudes may be adjusted to permit their combination into a single parameter, which may then be correlated with biologic effects. Only an approximate solution of this problem is forthcoming with the information at hand, but by its aid a correlation of dose and results is facilitated.

The interpretation of the influence of quality on dosage still remains unsettled. With sources of radiation of different qualities it has been difficult to dissociate effects due to differences in volume or in time distribution from those due to more intrinsic properties—absorption, ion density and distribution, etc. The influence of the latter has been isolated in a few instances. For example, the variation in the erythema dose corresponding to differences in quality can be well correlated with differences in absorption: to a close approximation the doses are inversely proportional to the two-thirds power of the corresponding mass absorption coefficients in water. Both types of effect must contribute to the disparity in clinical dosage observed when sources of radiation with pronounced differences in quality are employed. In our particular subject equal biologic changes in equal numbers of days require that the dose of gamma rays be about 50 per cent greater than that of roentgen rays. Accordingly in obtaining the total doses delivered to points A and B, the gamma-ray doses have been multiplied by a correction factor of 0.67 before adding them to the roentgen-ray doses. Roentgen rays of several qualities were also employed in the treatment of our cases but we have observed no biologic differences sufficiently pronounced to suggest that the change in wavelength *in this range* need be taken into account in comparing doses. It is possible that small differences would be detected by more critical tests; still they would have little practical importance.

In examining the other components of the clinical dose it becomes necessary to deal separately with the doses at points A and B. The dose at point A in the patients that recovered may be presumed to reveal the dose requirements for control of the primary tumor within the limitations imposed by local tolerance. Fluctuations in the paracervical dose with respect to the duration of treatment will be discussed first.

It was demonstrated in our previous report that time and dose are positively correlated, and an empirical equation was

TABLE V

CALCULATION OF THE CONSTANTS FOR THE REGRESSION EQUATION BETWEEN DOSE AND TIME

Paracervical Dose

Item	No. Days t	Average Dose D	No. of Cases n	Log of Time x	Log of Dose y	$n(x-\bar{x})^2$	$yn(x-\bar{x})$	Y	$n(y-Y)^2$
1	2	3,130	3	0.301	3.4955	5.14987	−13.73941	3.4811	0.0002
2	5	4,354	10	0.699	3.6389	8.32109	−33.19405	3.5740	0.0420
3	6	4,451	9	0.7782	3.6485	6.24500	−27.35280	3.5925	0.0279
4	9	4,111	5	0.9542	3.6140	2.15825	−11.87199	3.6336	0.0020
5	13.9*	5,411	3	1.1431	3.7333	0.65735	− 5.24267	3.6777	0.0093
6	23.4	5,275	3	1.3699	3.7223	0.17467	− 2.69457	3.7307	0.0003
7	29.2	5,616	5	1.4653	3.7494	0.10643	− 2.73519	3.7529	0.0001
8	32.3	6,111	10	1.509	3.7861	0.10445	− 3.86939	3.7631	0.0050
9	35.5	6,408	9	1.5509	3.8067	0.03272	− 2.06590	3.7729	0.0099
10	38.0	6,978	9	1.5797	3.8437	0.00893	− 1.08969	3.7796	0.0369
11	40.6	6,684	10	1.6085	3.825	0.00007	− 0.10328	3.7864	0.0150
12	42.8	6,381	21	1.6315	3.8049	0.00865	+ 1.62203	3.7917	0.0042
13	45.5	6,431	19	1.6578	3.8083	0.04126	+ 3.37187	3.7979	0.0019
14	48.1	6,679	27	1.6825	3.8247	0.13726	+ 7.36293	3.8036	0.0108
15	51.3	6,258	21	1.7101	3.7964	0.20541	+ 7.88474	3.8101	0.0042
16	54.1	6,604	17	1.7328	3.8198	0.25137	+ 7.89629	3.8154	0.0003
17	56.7	6,142	14	1.7537	3.7883	0.28429	+ 7.55766	3.8203	0.0140
18	60.2	6,008	19	1.7793	3.7787	0.53689	+12.06879	3.8263	0.0437
19	63.9	6,783	16	1.8053	3.8314	0.64047	+12.64247	3.8323	0.0000
20	67.8	6,101	5	1.8311	3.7854	0.24178	+ 4.16205	3.8383	0.0140
21	72.4	6,156	10	1.8597	3.7893	0.61752	+ 9.41641	3.8450	0.0480
22	77.1	5,967	10	1.887	3.7758	0.76066	+10.41366	3.8514	0.0570
23	82.7	6,828	12	1.9173	3.8343	1.21806	+15.25783	3.8585	0.0072
24	93.7	6,806	8	1.9719	3.8329	1.04084	+11.06022	3.8712	0.0120
TOTALS			275			28.94329	+ 6.75801		0.3659
									$s^2=0.00134$
MEANS				$\bar{x}=1.6081$	$\bar{y}=3.7870$				$s=0.03660$

$$m=\frac{S(ny(x-\bar{x}))}{S(n(x-\bar{x})^2)}=\frac{6.75801}{28.94329}=0.233$$

$Y=\bar{y}+m(x-\bar{x})$

$Y=3.787+0.233(x-1.6081)$

$Y=3.4108+0.233x$

$D=Kt^m$

$D=2575t^{0.233}$

Y = log of dose calculated from equation.

* Entries beyond item 4 give the geometric mean of several observations on closely adjacent or consecutive days.

proposed that approximately reproduced the paracervical doses in 44 three year survivors. The following simpler relation (the equation of a parabola) was fitted to the dosage in 67 survivors and included in a report before the First Mexican Cancer Congress in November, 1943: $D=Kt^m$, where D was the quality-corrected dose to the paracervical region (point A), t, the total number of days of treatment and K and m, constants with values respectively 2,550 and 0.24. The same relation could be fitted to the doses in 138 survivors published by Tod,[8] with only small differences in the values of the constants. Confirmation is obtained from the cases now under analysis. The values of the constants are calculated in Table v from the doses in 275

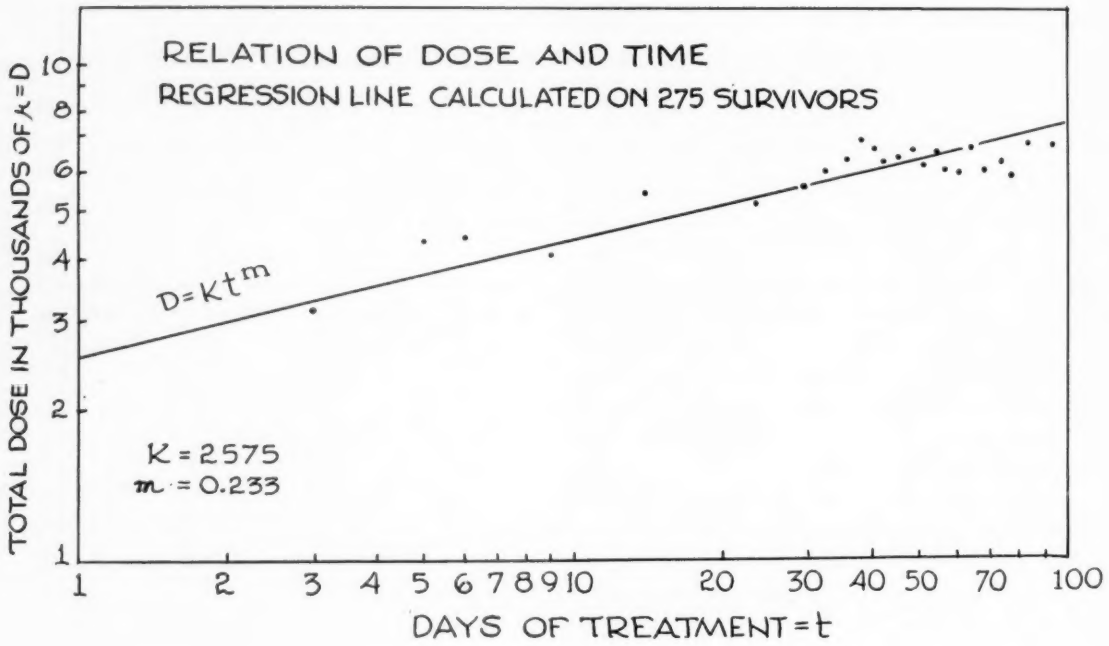
RELATION OF DOSE AND TIME
REGRESSION LINE CALCULATED ON 275 SURVIVORS
TOTAL DOSE IN THOUSANDS OF r = D
D = K t^m
K = 2575
m = 0.233
DAYS OF TREATMENT = t
1 2 3 4 5 6 7 8 9 10 20 30 40 50 70 100

FIG. 1

survivors treated in 100 days or less. Accordingly the regression line between dose and time shown in Figure 1 has the following equation:*

$$D = 2{,}575 \quad t^{0.23} \qquad (1)$$

which gives the mean effective paracervical dose, D (corrected for quality) for any number of days t, within the range of the observations plotted. It is well to recognize that because of the low order of accuracy inherent in the calculation of the dose to point A, and because of the wide scatter in the calculated values, the estimates given by the equation are subject to an error just exceeding 7 per cent. This is nevertheless acceptable for clinical application.

Variation in dose with respect to tumor size will not be estimated, but the influence of tumor extent on the magnitude of the dose can be appreciated by comparing the doses corresponding to different stages.

* A similar relation was derived by Strandqvist[6] from a study of 220 carcinomas of the skin and lip. In comparing the values given by the two expressions it is necessary to take into account that Strandqvist dosage yields over 85 per cent control in carcinomas with a mean cross section of 12.4 cm.^{2}, whereas equation (1) gives *median* effective dosage for lesions with an estimated mean cross section of 34 cm.^{2}

Fluctuation in dose due to differences in time can be eliminated by expressing the paracervical dose received by each patient as a percentage of the value given by equation (1) that corresponds to the duration of her treatment, the equation value itself being considered 100 per cent. Thus, a patient receiving 5,200 r in forty days will be said to have had a dose of 85 per cent, because according to equation (1) the mean paracervical dose in forty days is 6,100 r, —and similarly in all other cases. Paracervical dosage is specified in this manner in Table VI and in all subsequent tables.

Table VI gives the results in the uncomplicated cases in relation to the paracervical dose and the stage of the disease. It should be noted that the central values, 96–105 per cent, yield 52 per cent survival in all stages combined. The regression line thus gives the median as well as the mean effective doses. While prediction of the individual result is impossible, it can be anticipated with considerable assurance that in any other sample with essentially the *same stage distribution* the survival rate will not differ significantly from 50 per cent

TABLE VI

PARACERVICAL DOSE AND RESULTS; UNCOMPLICATED CASES

Paracervical Dose	Stage											
	I*		II		IIIA		IIIB		IV		Total	
Less than 80%	4	100%	11	55%	8	12%	11	9%	2	50%	36	36%
80– 95%	23	83%	55	45%	73	37%	40	23%	7	14%	198	41%
96–105%	10	90%	25	68%	41	49%	19	16%			95	52%
106–120%	15	60%	43	63%	49	37%	33	39%	6	0%	146	46%
Over 120%	4	50%	9	56%	4	50%	5	60%			22	55%
TOTAL	56	77%	143	56%	175	39%	108	27%	15	13%	497	45%

* In each stage column the first figure indicates the number of patients and the second figure the survival rate.

if the doses given by the equation are administered systematically.

Since recoveries occur with a variation in dosage that exceeds ±20 per cent of the values given by the equation, it will be understood, of course, that the regression line is not intended to supply the only doses that will prove effective. The empirical treatment of carcinoma of the cervix would not be so successful if cure or failure depended on strict adherence to an inflexible set of dosage values. There is no critical dose level that can be identified as "the lethal dose"; instead, there is a broad range of doses that prove effective in some instances. However, the assumptions are tenable that a greater proportion of recoveries may be secured in certain segments of the range, and that the dosage level may require modification in the presence of certain features of the disease. If these assumptions were confirmed dosage could be adjusted accordingly, and the effectiveness of treatment would be materially enhanced. For this reason we will endeavor to test their validity.

As indicated in Table VI the results improve with higher doses in some stages, but considerable over-all irregularity exists. This is due in part to the smallness of some of the groups, but the findings suggest that another factor, disturbing the consistency of the pattern, may also be at work. To clarify this point the cases have been divided into three groups, corresponding to the major differences in technique (ignoring variation in the paracervical dose for the time being), and the results appear in Table VII. One group had radium only; it constitutes a rather small sample and it

TABLE VII

COMPARATIVE RESULTS ACCORDING TO TECHNIQUE; UNCOMPLICATED CASES

	Radium Alone	Radium with Parametrial Roentgen-Ray Dose of		Total
		34–4,800 r	20–3,300 r	
No. of cases	51	208	238	497
Proportion Stages I and II	55%	41%	36%	40%
Proportion with paracervical dose less than 80% of values from equation (1)	4%	9%	6%	7%
Survivors	21	78	123	222
Survival rate	41%	38%	52%	45%

$X^2 = 9.311$, $n = 2$, $P < 1\%$

may be that the results are not truly representative of the possibilities of this method of treatment. The other two columns give the cases that had both radium and external roentgen therapy subdivided according to the amount of roentgen radiation administered to point B. Two hundred and eight cases were treated by techniques *f* and *g* and received doses of 3,400–4,800 r; 238 cases received doses of 2,000–3,300 r using techniques *d*, *h*, *j* and *l*. The last group shows significantly better results in spite of a poorer stage distribution and an incidence of low paracervical doses that differs little from the other two. It follows that recovery is dependent not only on the paracervical but also on the parametrial dose, and that the highest levels of the latter do *not* produce the best results. The point merits emphasis in view of the frequent statements in the literature to the effect that improved results could be achieved by the administration of substantially greater doses of radiation to the lateral extensions of the disease along the pelvic wall. This expectation is not borne out by the facts. On the contrary, they establish that *high* parametrial dosage is deleterious when delivered by combined external and intracavitary irradiation. Even with small, widely separated fields the total volume exposed to high dosage is so large that the adverse effects of this factor outweigh the possible benefits of greater doses to the areas of metastatic involvement. Consequently if high dosage can yield results that are better in fact than those obtained with the moderate doses we employed, it will have to be delivered with a completely different volume distribution.

It is thus seen that with the methods of radiation we employed, to be advantageous the dose at point B must be kept within certain bounds. The restrictions can be logically interpreted as the limits of normal tissue tolerance, transgression of which is known to be detrimental. It now becomes necessary to determine from the data the parametrial dosage that is within tolerance, and the manner in which it fluctuates with variation in volume and in time.

Clinical experience has abundantly established that the dose of radiation tolerated by the tissues diminishes as the irradiated volume becomes larger, though the quantitative relations involved have remained obscure. Obviously, the volume to be considered is that defined by the radiation distribution itself, which depends on quality, focal distance, and the area and disposition of the fields. Under the circumstances one is compelled to refer tolerance to surface area, or, more generally, to the cross section of the volume receiving high dosage. With the six or eight field distribution employed in our cases the cross section is given by the combined area of the anterior or the posterior fields together with the intervening gap, *e.g.*, 330 cm.^{2} is the cross section in technique *d*, in which six 10 by 15 cm. fields were used, the two anterior and the two posterior with a central separation of 2 cm. The expansion of the cross section in the depths due to beam divergence will be disregarded for reasons that will become apparent later (see Appendix). For convenience the radius of the circle of area equal to that of the cross section will be used as the "volume" variable. Since it is known that the tolerance dose increases as treatment is prolonged, it appears possible to fit to the parametrial dosage data an equation of the type $D_B = Ef(t)/f(r)$, where D_B is the dose in roentgens, t the number of days of treatment, r the radius of the area of cross section, and E the constant of proportionality. Further, it may be surmised that both $f(t)$ and $f(r)$ are power functions with fractional exponents. Because the equation has two independent variables the material was studied with the object of collecting enough cases to permit keeping the value of one of the variables fixed while the characteristics of the other were determined, but the data did not prove suitable for the purpose.* It was decided, therefore, to make provisional use of the regression line for the paracervical

* Solution by simultaneous equations is possible but the method is laborious.

Table VIII

AVERAGE PARAMETRIAL DOSES IN IRRADIATION TECHNIQUES USED

Technique	Radius of Cross Section cm.	No. of Survivors	Average Dose per cent*
h	6.91	26	64.4
l	6.91	101	65.8
g	7.57	30	79.3
f	7.97	74	73.9
j	8.37	30	58.1
d	10.25	6	55.8

* 100% = values given by equation (1).

doses as a means of excluding fluctuation in the duration of treatment, on the assumption that the variation in the doses at points A and B is alike with respect to time. It will become evident that such assumption is not strictly true, but the distortion it introduces is so small that it may be neglected in this problem. With certain exceptions the total parametrial dose for each survivor thus is to be expressed as a percentage of the regression line value corresponding to her number of days of treatment; the exceptions include cases receiving radium alone and those treated in more than a hundred days. Table VIII gives the provisional average percentage values of the parametrial doses administered by each technique. These figures should give approximately the average parametrial doses, unaffected by the duration of treatment, corresponding to cross sections of different dimensions. It may be seen that the averages for techniques *f* and *g* do not conform with the trend shown by the others. Since it has been shown that the results achieved with them are inferior, we are justified in concluding that the parametrial doses administered exceeded tolerance, and they will be excluded from the calculation of the volume factor. Assuming that $f(r)=r^c$, Table IX gives the calculation of c derived from the parametrial doses corresponding to techniques *h*, *l*, *j*, and *d*. The value $c=-0.45$ obtained closely approaches the value to be anticipated from the physical characteristics of the volume distribution (see Appendix); for this reason it can be considered acceptable and a second approximation will not be attempted. The constants for the relation of time and dose may now be evaluated using the product $D_B r^c$ as the dependent variable; that is, the

Table IX

RELATION OF PARAMETRIAL DOSE AND RADIUS OF CROSS SECTION
CALCULATION OF VOLUME FACTOR

Technique	Radius	Dose per cent*	*n*	Log *r* x	Log *D* y	$n(x-\bar{x})^2$	$yn(x-\bar{x})$
hl	6.91	64.7	127	0.8395	1.8109	0.05925	−4.96766
j	8.37	58.1	30	0.9227	1.7642	0.11384	+3.26024
d	10.25	55.8	6	1.0107	1.7466	0.13428	+1.56775
Totals			163	140.3617	293.3899	0.30737	−0.13967
Means				0.8611	1.79994		

$$c=\frac{S[yn(x-\bar{x})]}{S[n(x-\bar{x})^2]}=-\frac{0.13967}{0.30737}=-0.454$$

$$y=\bar{y}+c(x-\bar{x})$$
$$=1.79994-0.45(x-0.8611)$$
$$=1.79994+0.3918-0.45x$$
$$y=2.19174-0.45x$$

$$D=\frac{155.5}{r^{0.45}}\%$$

n = number of cases.
* 100% = values given by equation (1).

TABLE X

CALCULATION OF TIME SLOPE

Parametrial Doses

Item	t^*	$D_B r^c$	$x = \log t$	$y = \log (D_B r^c)$	n	$n(x-\bar{x})^2$	$yn(x-\bar{x})$
1	21.4	6197	1.3313	3.7922	2	0.27306	− 2.80244
2	28.8	9570	1.4593	3.9809	5	0.29161	− 4.80694
3	32.1	9893	1.5065	3.9953	9	0.33977	− 6.98658
4	36.6	11107	1.5632	4.0456	18	0.34081	−10.02014
5	41.2	10657	1.6150	4.0276	18	0.13251	− 6.22023
6	44.0	10912	1.6438	4.0379	23	0.07473	− 5.29369
7	47.6	11210	1.6776	4.0496	36	0.01938	− 3.38223
8	52.1	11215	1.7167	4.0498	30	0.00758	+ 1.93175
9	56.8	12220	1.7548	4.0873	24	0.06998	+ 5.29714
10	62.1	11460	1.7934	4.0592	24	0.20579	+ 9.02117
11	66.7	11340	1.8243	4.0547	8	0.12202	+ 4.00604
12	73.9	11415	1.8689	4.0574	9	0.25432	+ 6.13844
13	83.1	12730	1.9195	4.1049	9	0.43047	+ 8.07968
14	95.9	13050	1.9818	4.1158	5	0.39481	+ 5.78270
TOTALS			374.1830	890.9088	220	2.95684	+ 0.74467
MEANS			1.70083	4.0496			

$$a = \frac{S[yn(x-\bar{x})]}{S[n(x-\bar{x})^2]} = \frac{0.74467}{2.95684} = 0.252$$

$$Y = 4.0496 + 0.25(x - 1.70083)$$
$$Y = 4.0496 - 0.4252 + 0.25x$$
$$Y = 3.6244 + 0.25x$$
$$D_B r^c = 4211\, t^{0.25}$$

$$D_B = \frac{4200 t^{0.25}}{r^{0.45}}$$

n = No. of cases

* Each item represents the geometric average of consecutive or closely adjacent observations.

parametrial dose (in roentgens) received by each patient is to be multiplied by the value of the radius function appropriate to the technique employed in her case, and the products correlated with the duration of treatment. The computation based on 220 survivors appears in Table X; we have excluded 31 survivors that received radium alone, 23 treated in over a hundred days and 24 that received radium first. The calculations provide the following solution for the estimation of tolerance dose in the pelvis:

$$D_B = \frac{4,200}{r^{0.45}}\, t^{0.25}$$

roentgens, (2) which applies in a strict sense only to the radiation qualities employed in our material (half-value layer 3–5 mm. Cu). Extrapolation of the volume factor below the range of the observations will appear valid, we believe, from the discussion in the Appendix; on the other hand, the dose-time relation for periods of less than three weeks must be considered tentative since the observations do not cover the interval.

It should be pointed out that the adjustment of dosage performed with the volume factor $1/r^c$ is dependent on the characteristics of the radiation distribution employed. The factor is not indicative of a general biologic property, but simply of the tissue requirements for a particular type of spatial distribution, consequently it will not apply when the distribution is altered radically. The relationship of clinical dosage and the volume irradiated will be considered further in the Appendix.

Line graphs of the time and the volume factors appear in Figure 2; one can obtain

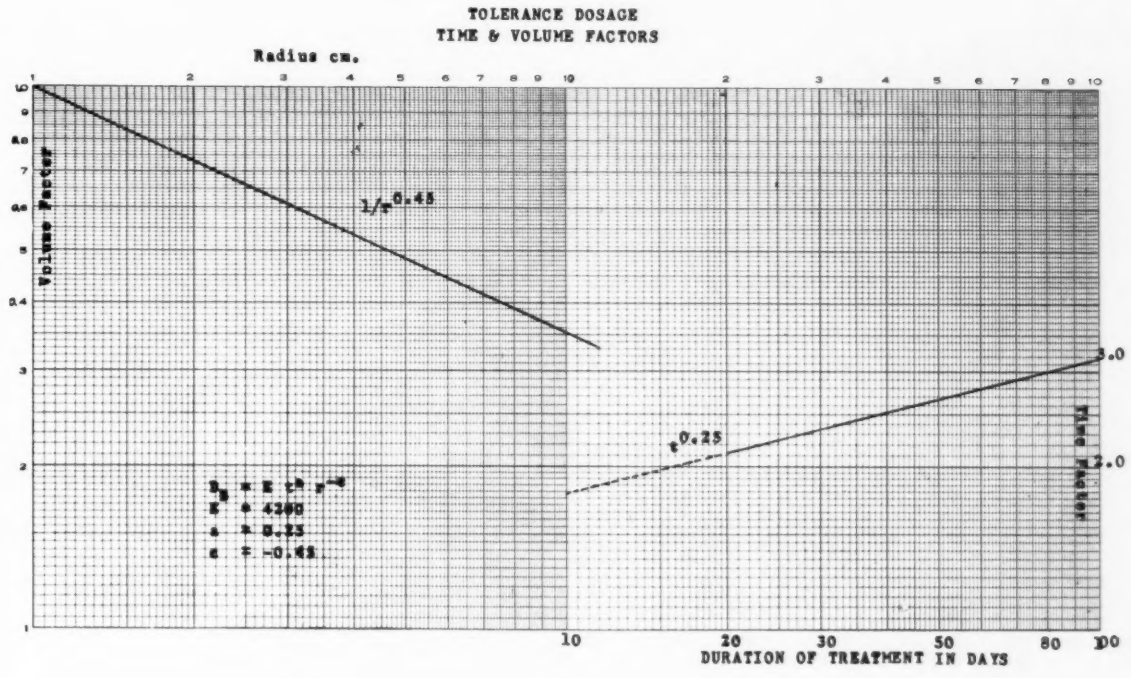

Fig. 2

from them the values corresponding to any chosen combination of time and radius of cross section; the product of such values multiplied by the constant E (4,200) gives the tolerance dose for the combination selected.

The value of the exponent m appearing in the regression equation for paracervical dosage differs significantly from 0.25, which, as just shown, is the value of the exponent a in the tolerance dose equation. However, when the variance of the two exponents is taken into account their difference divided by the standard error gives a deviation of only 1.3. We have therefore no evidence of a real difference in the ability to recuperate from radiation between tumor and normal tissue. This point deserves thorough verification because it has important implications.

To permit comparison, the parametrial dose for each case will be expressed as a percentage of the values given by equation (2) that correspond to the duration of treatment and to the volume employed; the value obtained from the equation for each combination will be considered to represent 100 per cent. Parametrial dosage in Table XI and in all subsequent tables is stated in this fashion.

It has been established that the results become significantly impaired when the parametrial dose is excessive (Table VII). This conclusion is confirmed by the information recorded in Table XI which presents the stage results in the uncomplicated cases in relation to the doses at points A and B. With the exception of Stage III_B the survival rates are consistently lower in the groups receiving parametrial doses above 105 per cent; while in Stage I the groups are too small to rule out chance fluctuations, the differences in Stages II and III_A and in the total results can be shown to be statistically significant. It will be demonstrated that in Stage III_B another factor is interposed that induces the apparently contradictory findings.

The true influence exerted by dosage is revealed in a more regular pattern by the combined results in all stages, with the survival rates at each dose segment corrected for differences in stage distribution (Table XII). It may be seen that the survival rates

TABLE XI

STAGE RESULTS IN UNCOMPLICATED CASES

Paracervical Dose	Parametrial Dose									
	26–35%*		40–89%		90–105%		Over 105%		Total	
Stage I										
Less than 80%[a]			4	100%					4	100%
80– 95%	1	0%	4	75%	13	92%	5	80%	23	83%
96–105%	1	—	1	—	6	100%	2	50%	10	90%
106–120%	5	40%			2	100%	8	63%	15	60%
Over 120%	2	0%					2	100%	4	50%
TOTAL	9	33%	9	89%	21	95%	17	71%	56	77%
Stage II	1	0%	8	63%	2	50%			11	55%
80– 95%			10	30%	28	64%	17	24%	55	45%
96–105%	3	67%	4	100%	11	73%	7	43%	25	68%
106–120%	14	79%	1	—	3	67%	25	52%	43	63%
Over 120%	1	0%					8	63%	9	56%
TOTAL	19	68%	23	57%	44	66%	57	44%	143	56%
Stage IIIA										
Less than 80%			6	0%	2	50%			8	12%
80– 95%	3	0%	8	25%	47	45%	15	27%	73	37%
96–105%	3	67%	1	0%	22	55%	15	40%	41	49%
106–120%	4	25%	2	50%	9	67%	34	29%	49	37%
Over 120%	2	50%					2	50%	4	50%
TOTAL	12	33%	17	18%	80	50%	66	32%	175	39%
Stage IIIB										
Less than 80%	3	0%	4	25%	3	0%	1	0%	11	9%
80– 95%	1	0%	5	20%	29	28%	5	0%	40	23%
96–105%	2	0%	1	0%	7	14%	9	22%	19	16%
106–120%	4	25%	1	0%	6	50%	22	41%	33	39%
Over 120%	1	0%					4	75%	5	60%
TOTAL	11	9%	11	18%	45	27%	41	34%	108	27%
Stage IV										
Less than 80%			1	—	1	0%			2	50%
80– 95%	2	0%	1	0%	3	33%	1	0%	7	14%
106–120%					1	0%	5	0%	6	0%
TOTAL	2	0%	2	50%	5	20%	6	0%	15	13%
All Stages										
Less than 80%	4	0%	23	48%	8	25%	1	0%	36	36%
80– 95%	7	0%	28	32%	120	50%	43	28%	198	41%
96–105%	9	56%	7	71%	46	59%	33	39%	95	52%
106–120%	27	55%	4	50%	21	62%	94	39%	146	46%
Over 120%	6	17%					16	69%	22	55%
TOTAL	53	40%	62	44%	195	52%	187	38%	497	45%

[a] 100%= values given by equation (1).
* 100%= values given by equation (2).

TABLE XII

RESULTS IN UNCOMPLICATED CASES IN RELATION TO PARACERVICAL AND PARAMETRIAL DOSAGE

All Stages Combined

Paracervical Dose[e]	Parametrial Dose[i]									
	26–35%*		40–89%		90–105%		106–151%		Total[a]	
Less than 80%	4	0%	23	38%	8	32%	1	0%	36	17%
80– 95%	7	0%	28	31%	120	52%	43	24%	198	33%
96–105%	9	56%	7	41%	46	56%	33	38%	95	47%
106–120%	27	43%	4	54%	21	65%	94	41%	146	52%
Over 120%	6	18%					16	65%	22	55%
TOTAL[c]	53	24%	62	40%	195	55%	187	32%	497	45%

* In each column the first figure indicates the number of cases and the second the survival rates corrected for differences in stage distribution.

[a] Corrected for differences in parametrial dose distribution.

[c] Corrected for differences in paracervical dose distribution.

[e] 100% = values given by equation (1).

[i] 100% = values given by equation (2).

improve steadily as the paracervical dose rises; on the other hand, the results reach a maximum when the parametrial doses coincide with tolerance and decrease with both lesser and larger doses.

It is of interest that the observations are consistent with a log-normal distribution of radiocurability. Without undertaking to establish it rigorously, the point can be illustrated with a sample of 190 cases selected from the central columns in Table XI. In order to make the material as homogeneous as possible we have discarded 60 cases that had radium therapy first and 7 Stage IV cases. Though selection favors the results, it makes the relation between paracervical dose and survival easier to appreciate by excluding extraneous influences; still the relative degree of success associated with various dose levels is not affected. Table XIII presents the results in the selected sample in relation to the paracervical dose; to improve comparability the rates are corrected for differences in stage distribution, and the corresponding probits are tabulated. The plot of the logarithms of

TABLE XIII

RELATION OF TUMOR DOSE AND CURABILITY; SELECTED SAMPLE*

Paracervical Dose[e]	No. of Cases	Survival Rate	Corrected Survival Rate[a]	Average Paracervical Dose[c]	Probit of Survival Rate
Less than 80%	5	20%	10.1%	58.6%	3.72
80– 90%	39	38%	41.5%	85.7%	4.79
91– 95%	73	44%	44.5%	93.2%	4.86
96–105%	49	63%	56.1%	98.9%	5.15
106–112%	18	61%	63.0%	109.7%	5.33
112–120%	6	67%	64.7%	116 %	5.38
TOTAL	190	50%	50 %	94.4%	

* All patients treated by roentgen irradiation followed by radium. Parametrial dosage 40–105% of values given by equation (2).

[a] Corrected for differences in stage distribution.

[c] 100% = values given by equation (1).

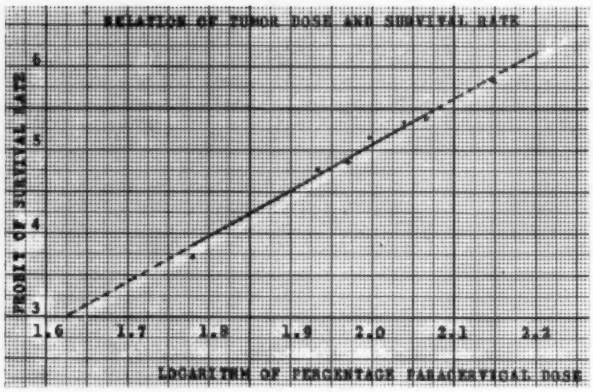

FIG. 3

the paracervical doses against the probits is essentially linear (Fig. 3), that is, the logarithmic dose and survival are related by a typical sigmoid curve, which on differentiation gives the distribution of radiocurability (Fig. 4). This, then, approximately represents the theoretical trend in recovery in the presence of unlimited normal tissue tolerance. From the standpoint of tumor effects the implication clearly is that the best dose is the highest dose. In actuality the cervix and adjacent structures will undergo necrosis, of course, if the administration of radiation is pushed beyond certain limits. These cannot be specified with confidence, but it is our impression that the threshold of cervical necrosis lies in the neighborhood of 125 per cent of the doses given by equation (1); only cautious exploration of the dosage range beyond 120 per cent will determine whether or not the gain in salvage justifies the risks involved. Nevertheless, even if dosage is maintained below the figures just stated, the potentialities for improvement in the results appear substantial since dosage ordinarily is kept considerably below the highest possible levels.

Fortunately, this policy concerning dosage need not be followed uniformly. Study of the paracervical doses associated with survival in the various stages, and in cases with special features, discloses that certain types of lesions respond satisfactorily in the lower segments of the effective range; there is, in fact, a rough parallelism between the clinical extent of the disease and the dose required for its control, with the more extensive lesions requiring the greater doses. In addition, other features of the plan of

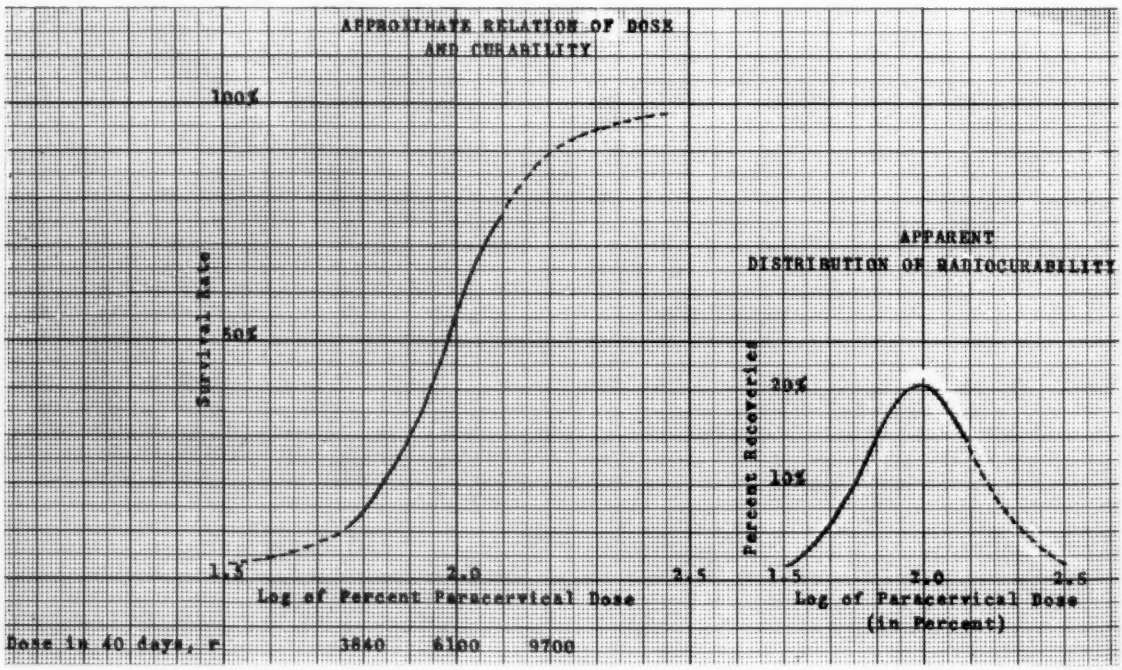

FIG. 4

Table XIV

VOLUME AND DOSE RELATIONS IN STAGE III_B

Group		No. of Cases	Survival Rate	X^2	Probability
	a) *Area of cross section*				
1	150 cm.² or less	58	17%	5.9	1.5%
2	180–330 cm.²	50	38%		
	b) *Paracervical dose in Group 2*				
3	72–105%	21	20%	4.2	4 %
4	106–123%	29	52%		
	c) *Parametrial dose in Group 4*				
5	90–105%	6	50%		
6	106–142%	23	52%		

treatment affect recovery. These topics will be considered next.

Among 30 Stage I cases receiving adequate parametrial dosage 28 recovered with paracervical doses of 57–118 per cent (average 88 per cent; Table XI). No decisive advantage is gained at the higher levels, nearly all being controlled with relatively low dosage. Under the circumstances a dose of 90–95 per cent can be adopted for routine administration since it reduces the risk of complications from the treatment itself without sacrificing opportunity for recovery.

In Stage II the results are better when the paracervical dose exceeds 95 per cent. If all cases with parametrial doses of less than 105 per cent are grouped together (Table XI) we obtain 49 with paracervical doses of 95 per cent or less and 37 with higher ones; the survival rates are 55 per cent and 76 per cent respectively, a statistically significant difference ($X^2=3.87$, P 4.9 per cent). Optimal dosage cannot be stated with assurance but it may be placed tentatively in the range 100–110 per cent.

The results in Stage III_A also are better with paracervical doses above 95 per cent, but the differences are inconclusive. Nevertheless, the observations suggest that the paracervical dose should be beyond 110 per cent; as a matter of fact in this as in the more advanced stages of the disease the practice of administering the highest possible paracervical dose is most likely to improve the results.

The dimensions of the volume irradiated predominantly influence the results of treatment in Stage III_B; to achieve the best results a generous zone of the pelvis must be irradiated. This is brought out in Table XIV by a regrouping of the cases in Table XI. Fifty-eight cases were treated with radium alone or with radium and roentgen rays using techniques *h* and *l*; the cross section of the irradiated volume in these cases was 150 cm.² or less. In the other 50 cases the cross section was larger, treatment being administered by techniques *d*, *f*, *g* and *j*. It may be seen from the tabulation that survival is significantly better in the cases treated with the larger fields, and that with large fields the results are further improved significantly by using paracervical doses of 106 per cent or more. The number of cases is insufficient to demonstrate an advantage when tolerance is not exceeded.

The Stage IV cases form a sample too small to permit the formulation of a policy of treatment. However, it would seem logical to employ the same principles of treatment as in Stage III_B.

The influence of the dimensions of the irradiated volume on the results is presented in Table XV. In each stage only the cases with the most successful paracervical doses are included. In contrast to the findings in

TABLE XV

RELATION TO DIMENSIONS OF VOLUME IRRADIATED AND THE RESULTS

Stage	I				II				IIIA				IIIB			
Paracervical Dose	105% or less				96% or More				96% or More				106% or More			
Area of cross section	150 cm.² or less		180 to 330 cm.²		150 cm.² or less		180 to 330 cm.²		150 cm.² or less		180 to 330 cm.²		150 cm.² or less		180 to 330 cm.²	
Parametrial dose																
25–35%	2	50%			18	72%			9	44%			5	20%		
40–105%	23	96%	5	80%	9	100%	10	60%	19	58%	15	53%	1	0%	6	50%
106–140%			7	71%	4	75%	36	50%	4	50%	47	32%	3	0%	23	52%
TOTAL	25	92%	12	75%	31	81%	46	52%	32	53%	62	37%	9	11%	29	52%

Stage IIIB, the results are consistently better in all the earlier lesions when the volume exposed to radiation is kept small. Chance variation cannot be excluded if each stage is considered separately, but significant differences are demonstrable if all the cases in Stages I to IIIA are combined. Thus, the survival rate is 74 per cent in 88 cases with irradiated cross section of 150 cm.² or less, and 47 per cent in 120 cases with larger ones; when these rates are corrected for differences in parametrial dose and in stage distribution they become 70 and 54 per cent respectively, a discrepancy that is too great to be fortuitous in samples of this size. Moreover, the irradiation of a small volume is advantageous in other respects; it reduces the integral dose, and by restricting the zone of tissue reaction it diminishes the discomforts of treatment and the risk of late sequels.

The material has also been analyzed with

TABLE XVI

RESULTS IN RELATION TO AGE AND DOSAGE; UNCOMPLICATED CASES

Age, Years	20–39[a]				40–54				55–85			
Parametrial Dose*	Central		Extremal		Central		Extremal		Central		Extremal	
Paracervical Dose												
Stage I												
57–105%	11	100%	1	—	11	91%	4	100%	6	83%	4	25%
106–128%			6	33%	2	100%	7	71%			4	50%
Stage II												
63–95%	9	55%	6	16%	24	50%	6	16%	15	67%	6	33%
96–116%	3	67%	13	54%	8	100%	24	71%	8	63%	21	48%
Stage IIIA												
75–95%	7	43%			27	41%	12	16%	30	33%	6	35%
96–115%	6	50%	12	25%	13	62%	29	45%	14	57%	19	26%
Stage IIIB												
72–105%	3	33%	6	0%	20	20%	6	16%	26	23%	9	11%
106–123%			7	71%	2	50%	16	25%	5	40%	8	50%
TOTALS	39	64%	51	37%	107	52%	104	45%	104	44%	77	35%
Combined totals		90	49%			211	49%			181	40%	
CORRECTED TOTALS[c]	39	53%	51	40%	107	52%	104	46%	104	50%	77	33%
Combined totals		90	47%			211	49%			181	41%	

* The cases in each age group have been subdivided according to the parametrial dosage values into: central, those with doses 40–105%, and extremal, those with doses 26–39% or 106 to 142%.

[a] In each column the first figure denotes the number of cases and the second the survival rate.

[c] Correction is for differences in paracervical dosage and in stage distribution.

TABLE XVII

CARCINOMA OF THE CERVICAL STUMP: RELATION OF DOSAGE AND RESULTS

Paracervical Dose	Parametrial Dose Values*					
	Central		Extremal		Total	
Stage I						
55– 89%	8	100%	2	100%	10	100%
90–120%	1	0%	2	100%	3	67%
TOTAL	9	89%	4	100%	13	92%
Stage II						
55– 89%	6	83%			6	83%
90–120%	2	50%	2	100%	4	75%
TOTAL	8	75%	2	100%	10	80%
Stage IIIA						
55– 89%	5	60%			5	60%
90–125%	7	43%	5	40%	12	42%
TOTAL	12	50%	5	40%	17	47%
Stage IIIB						
80–105%	7	71%	1	—	8	75%
106–120%			3	0%	3	0%
TOTAL	7	71%	4	25%	11	55%
All stages	36	69%	15	60%	51	67%

* Subdivision of the cases the same as in Table XVI.

the object of determining whether or not the sequence of treatment affects the results, but no significant effect can be detected. In cases treated with equal total doses it is immaterial whether roentgen or radium therapy is given first. Even so, it is generally preferable to begin treatment with roentgen therapy, because the time distribution of the dose is more easily controlled.

The therapeutic results in relation to age appear in Table XVI. The response to treatment does not differ significantly at any of the age periods shown. With parametrial doses within tolerance (central values of the range) the total results are almost identical in the three age groups if allowance is made for differences in stage distribution and in the proportion of cases at the various paracervical dose levels. In cases that were treated with radium only, or with parametrial doses exceeding tolerance (*i.e.*, the extremal values of the range) some differences in the total results persist when the correction is made for the factors just mentioned. While these differences may represent nothing more than chance variations they are too consistent to be ignored. It is quite likely that with larger samples they would become meaningful, and it seems reasonable to interpret them as evidence of the lessened ability to withstand heavy dosage in youth and in old age.

As shown in Table XVII carcinoma of the cervical stump is therapeutically favorable in all stages. The dosage required to produce equal rates of survival is about 12 per cent lower than in the uncomplicated cases. An increased tumor sensitivity is suggested, but the observations are not

TABLE XVIII

ADENOCARCINOMA OF THE CERVIX

Paracervical Dose	Parametrial Dose					
	26–105%		106–138%		Total	
Stage I						
70– 95%	2	0%	1	0%	3	0%
96–114%	4	25%	2	50%	6	33%
Stage II						
70– 95%	1	0%			1	0%
96–121%	6	67%	4	25%	10	50%
Stage IIIA						
70– 95%	2	50%			2	50%
96–122%	5	0%	5	20%	10	10%
Stage IIIB						
70– 95%	4	50%	1	0%	5	40%
96–117%	2	50%	1	0%	3	33%
Stage IV						
95–113%	2	0%	2	0%	4	0%
TOTAL	28	32%	16	19%	44	27%

numerous enough to establish the matter categorically. It may be conjectured that the smaller tumor volume, or that a change in the endocrine background of the host, may be responsible for the difference. Whatever the reason, the principles of treatment are essentially the same as in the uncomplicated cases, except for a tentative downward revision in the dosage.

The data on adenocarcinoma of the cervix are presented in Table XVIII. The survival rates vary irregularly, and the group is too small to derive any recommendations for a better plan of treatment.

The relation of dosage and results in infected cases appears in Table XIX. The lack of resemblance to the trend shown in the uncomplicated cases is caused in part by the small numbers involved, but an additional factor intervenes: the rate at which treatment is administered. Cases treated by techniques *f*, *g* and *h* received daily roentgen-ray doses of 125–195 r, whereas those treated by techniques *d*, *j*, and *l* had 100–122 r per day. The differences in results are shown in Table XIX, where 9 cases that had radium only are classified with the group receiving lower daily dosage. The higher daily doses must be judged to impair the results significantly ($X^2=4.34$, P 3.7 per cent) since the difference in the survival rates persists (*i.e.*, 19.3 per cent *vs.* 40.6 per cent) when allowance is made for differences in stage and dosage distribution.

The foregoing review of the clinical and dosage data, though incomplete in some respects, furnishes evidence favoring the adoption of a number of measures that should promote the success of radiation therapy in carcinoma of the cervix. By putting some of these measures into practice an improvement has been attained in our own cases, as illustrated in Table XX with unselected material. Using February 1, 1945, as a dividing line two almost equal series are obtained from the 943 cases analyzed. Comparison of the absolute results in the two successive periods shows some progress in the control of the disease. Since the advantage in the second series is retained when the survival rates are corrected for differences in stage distribution, the change must be attributed to better treatment and not to better material.

It would be premature to suppose that the full possibilities of radiation therapy have been achieved. Further gains can be anticipated from the complete utilization of the facts already discussed, and still more from the continual accumulation of precise dosage data, methodical study of which, it is hoped, will eventually permit the planning of treatment truly suited to each patient's individual needs.

SUMMARY

Correlation of therapeutic results and radiation dosage is undertaken in a group of 703 fully treated cases of cancer of the cervix selected from a series of 943 patients seen at the Charity Hospital of Louisiana in the six year period ending September 30, 1947. Doses in the pelvis from roentgen and gamma rays were precalculated at

Table XIX

RELATION OF DOSAGE AND RESULTS IN INFECTED CASES

Paracervical Dose	Parametrial Dose Values*					
	Central		Extremal		Total	
Stage I						
96–125%	2	100%	2	100%	4	100%
Stage II						
70– 95%	9	44%	3	0%	12	33%
96–120%	6	33%	6	50%	12	42%
Stage III_A						
80– 95%	11	27%	2	0%	13	23%
96–126%	12	16%	1	—	13	23%
Stage III_B						
70– 95%	24	25%	2	0%	26	23%
96–121%	15	20%	11	9%	26	15%
Stage IV						
80–103%	4	25%	1	—	5	40%

Stage	Results in Relation to the Daily Dose											
	I		II		III_A		III_B		IV		Total	
125 r or more	2	100%	14	36%	9	11%	32	9%	0		51	19%
120 r or less	2	100%	10	40%	17	29%	20	35%	5	40%	54	37%
Total	4	100%	24	38%	26	23%	52	19%	5	40%	111	28%

* Subdivision of cases the same as in Table xvi.

two points, one paracervical and one parametrial; these are used as the indicators of the tumor and the tolerance doses respectively. Fluctuation in dosage due to differences in radiation quality, in duration of treatment, or in the volume irradiated must be excluded before the influence of the magnitude of the dose on the results can be evaluated. A correction for quality is applied, and elimination of the effects of the other factors is accomplished by the use of two equations developed from the observa-

Table XX

CANCER OF THE CERVIX; COMPARATIVE 5 YEAR RESULTS

	Stage					"Corrected" Survival Rate
	I	II	III	IV	Total	
1941–45						
No. of cases	56	135	224	58	473	
Absolute survival	57%	37%	22%	5%	29%	28.1%
1945–47						
No. of cases	54	92	284	40	470	
Absolute survival	87%	65%	31%	5%	42%	42.8%

tions. Tabulation of the data shows that best results are obtained when both roentgen and radium therapy are employed, when the parametrial dose is kept within specified limits, and when the largest possible paracervical dose is administered. However, in Stages I and II and in lesions of the cervical stump high rates of survival are attained without recourse to the maximum tumor doses. In advanced lesions the use of large fields is advantageous, and in infected cases the administration of treatment at a low daily rate favors recovery. It is shown that the absolute results have been improved by a change in the plan of treatment, and additional gains in salvage are anticipated from better control of the tissue dose and from its adjustment to the features exhibited by the disease.

APPENDIX

It has been shown in the tolerance equation (2) that dosage can be adjusted to variation in volume by using the factor $1/r^c$. This implies that change in the irradiated volume is proportional to a power function of the radius of cross section, which may have an element of surprise, since it is customary to expect no regularity in the relation between depth dose and the size of the irradiated area, except for the obvious one of greater dosage with larger field. Analysis of depth dose data shows nevertheless that to a close approximation the relation between volume and radius is true, though only within certain limits. Fortunately, it happens to be valid in the volume distributions that are of interest in pelvic irradiation, as we shall now try to demonstrate.

In the simplest case, consider a roentgen-ray beam of circular cross section traversing a scattering medium, and let r be the radius of surface area and $\bar{y}$ be the depth, measured along the central ray, where 50 per cent of the surface dose is recorded. With surface dose constant, as area enlarges the irradiated volume receiving equal proportional dosage gains depth as well as cross section. As r increases, then, $\bar{y}$ will also increase, by virtue of the greater amount of scatter, but because of beam divergence the change in $\bar{y}$ will not be directly proportional to the change in the volume receiving a minimum dose of 50 per cent. Proportionality can be obtained by considering the shape of the irradiated volume and adjusting $\bar{y}$. The volume included between the surface, a parallel plane passing through $\bar{y}$ and the geometric edges of the beam is a frustum. Since the isodose surface passing through $\bar{y}$ is concave upwards the frustum represents only an approximation to the volume receiving a minimum dose of 50 per cent; however, the difference is unimportant because our interest lies not in the absolute dimensions of the volume but in the relative change in volume with respect to r, and for this purpose the approximation is adequate. Calculation is simplified by conceiving the irradiated volume to be cylindrical, that is, by assuming that the projection of the surface area remains constant at all depths, and correcting $\bar{y}$ to compensate for the change in configuration. A cylinder of volume equal to the frustum will have height $y'=\phi\bar{y}$, where $\phi=(1+F+F^2)/3$, $F=(f+\bar{y})/f$, $f=$ focal distance. With values of r 10 cm. or less the logarithmic plot of y' against r is rectilinear with slope c. Hence the relation between corrected half-depth and radius is given by $y'=hr^c$, where h is the y' intercept when $r=1$. If this is equated to dosage we obtain

$$2d=\frac{hr^c}{\phi y} \tag{3}$$

where d is depth dose stated as a decimal fraction of the surface dose, y is depth along the central ray (in cm.) and h and c are constant for a particular combination of quality and focal distance. From the manner of its derivation this expression cannot be expected to have general application; it over-simplifies the statement of depth dosage, and is inaccurate without some qualification. In reality the primary radiation varies exponentially with depth, and scatter is not uniform at all depths. Suitably modified the equation can denote these characteristics; but the principal advantage of such a change is to supply the approximate percentage doses over a wide range of depths, an accomplishment that is of no particular value since this information can be easily obtained from published tables. The essential relations bearing on spatial distribution, which are our main concern, appear in the equation as it stands; hence its limitations need be recognized.

In examining the depth distribution, differences become apparent at three zones, a superficial, an intermediate, and a deep, that lack sharp lines of demarcation. The equation is valid in the intermediate zone with values of

TABLE XXI

DEPTH DOSAGE CALCULATED FROM EMPIRICAL EQUATION*
COMPARISON WITH DEPTH DOSE TABLES†

Half-Value Layer 5 mm. Cu, 50 cm. distance, h 4.4 cm., $c=0.45$

Depth	Area in Square Centimeters					
	20	50	100	150	200	400
10 cm.						
Equation	27.6%	34.2%	39.9%	44.1%	46.5%	54.8%
Tables	29.3	34.8	40.9	44.4	47.0	49.7
13 cm.						
Equation	20.0	24.9	29.0	32.2	33.9	39.8
Tables	20.0	25.0	29.5	32.2	34.3	37.7
15 cm.						
Equation	16.8	20.8	24.1	26.8	28.2	33.1
Tables	16.1	20.2	23.9	26.2	27.6	31.4

* Equation (3).
† Mayneord and Lamerton.[4]

$y \doteqdot 2\text{–}4h$; in this range, as illustrated in Table XXI, the depth dosage given in the Mayneord and Lamerton[4] tables is reproduced fairly closely, except that when $r > 10$ cm. dose tends to be over-estimated. In order to test agreement between the physical and the clinical data we have used $c=0.45$, the constant derived from the analysis of the clinical material. In the deep zone the equation doses are larger than the ones furnished in the tables, mainly because primary radiation is over-estimated. Nevertheless for the depths that have significance in clinical application the distribution suffers no fundamental change, and the essential relations given by the equation can be verified in Table XXII for both the intermediate and the deep zones.

According to the equation when depth is constant the quotient of depth dose and r^c is also a constant. This is confirmed in the table using the product of d and v, the volume factor, which is the reciprocal of r^c, and testing areas 20–400 cm.^{2}, depths 8–20 cm. and qualities 1–5 mm. Cu half-value layer, all at 50 cm. distance. For this range of qualities c, calculated from data obtained by graphic interpolation, varies slightly, and we have used $c=0.43$ for all. The products for each depth are not identical, but they agree within ± 2–3 per cent of their median value. Another feature of the depth distribution shown by the equation is that with depth dose constant the product of the volume factor and the corrected depth is also a constant. This is tested for 30 and for 50 per cent depth dose using different qualities; the products in either case again agree within ± 2–3 per cent of their median value.

In the superficial zone the proportion of scatter is substantially reduced, and the smaller areas receive primary radiation predominantly; as a consequence the spatial distribution is markedly altered and the relations previously indicated no longer prevail.

For other qualities and focal distances h and c change in value. h increases with greater distances and harder radiation, and diminishes inversely. The value of c varies with focal distance, because with differences in beam divergence the volume corresponding to a given value of r cannot remain constant. The change in c with respect to quality corresponds to the behavior of scatter; c has maximum values for the qualities illustrated in Table XXII, and a decrease occurs both with harder and with softer radiation; for instance, c is 0.32 for soft radiation (half-value layer 1 mm. Al) at 15 cm. distance, and 0.3 for million volt radiation at 100 cm. distance. With longer distances and harder radiation, therefore, the spatial distribution permits the administration of greater doses than under the conditions considered in Table XXII.

From the foregoing it becomes apparent that the equation developed for depth dosage

TABLE XXII

RELATIONS OF ROENTGEN DEPTH DOSAGE* AND THE VOLUME FACTOR
50 CM. FOCAL DISTANCE

Field Area, cm.^{2}	20	50	100	150	200	400
Radius, r	2.5	4.0	5.6	6.9	8.0	11.3
Volume Factor, $v = 1/r^{0.43}$	0.672	0.551	0.475	0.436	0.41	0.353
1. *Points at Equal Depth*						
a) 8 cm. depth, H.V.L. 1 mm. Cu						
depth dose, *d*	31.2%	37.4%	42.9%	46.4%	49.6%	55.6%
product, *dv*	21.0	20.6	20.4	20.2	20.3	20.0
b) 9 cm. depth, H.V.L. 2 mm. Cu						
depth dose, *d*	29.1%	34.6%	40.4%	43.6%	46.6%	52.0%
product, *dv*	19.6	19.1	19.2	19.0	19.1	18.4
c) 11 cm. depth, H.V.L. 3 mm. Cu						
depth dose, *d*	23.5%	28.4%	33.5%	36.7%	39.2%	43.9%
product, *dv*	15.8	15.6	15.9	16.0	16.1	15.5
d) 14 cm. depth, H.V.L. 5 mm. Cu						
depth dose, *d*	17.9%	22.4%	26.5%	29.2%	30.9%	34.5%
product, *dv*	12.0	12.4	12.6	12.7	12.7	12.2
e) 20 cm. depth, H.V.L. 4 mm. Cu						
depth dose, *d*	9.2%	11.4%	13.1%	14.7%	15.2%	18.6%
product, *dv*	6.2	6.3	6.2	6.4	6.2	6.6
2. *Isodose Points*						
a) 30% depth dose, H V.L. 1 mm. Cu						
depth, *y*	8.2 cm.	9.4 cm.	10.7 cm.	11.4 cm.	12.2 cm.	13.8 cm.
corrected† depth, *y'*	9.6	11.3	13.1	14.2	15.4	17.9
product, *vy'*	6.5	6.2	6.2	6.2	6.3	6.3
b) 50% depth dose, H.V.L. 5 mm. Cu						
depth, *y*	5.8 cm.	7.0 cm.	8.1 cm.	8.7 cm.	9.3 cm.	10.0 cm.
corrected depth, *y'*	6.5	8.0	9.5	10.3	11.1	12.1
product, *vy'*	4.4	4.4	4.5	4.5	4.6	4.3

* Depth dosage from Mayneord and Lamerton.[4]
† Correction for beam divergence, see text.

satisfactorily indicates the relations between area, depth, and percentage depth dose in the deeper zones irradiated, though dosage is not given accurately for all depths. In the superficial zone the distribution is different and the problem of dosage must be handled separately.

It follows that the volume factor appearing in the tolerance equation has a concrete physical basis. The adjustment of dosage required is dependent on the characteristics of the radiation distribution employed, as well as on tissue properties. The relationship of clinical dosage and volume irradiated is disclosed by combining equations (3) and (2) (with $t=1$) which yields

$$D_B y' d = \frac{hE}{2} = C, \text{ a constant} \qquad (4)$$

Thus, for any particular combination of quality, focal distance, and time the product of the three factors in the left hand member is a constant when dose is assessed in the deeper zones. The link with volume is provided by y', which constitutes the ratio of surface area and the volume receiving a minimum dose D_B. Because radiation is not distributed uniformly

TABLE XXIII

COMPARISON OF TOLERANCE DOSAGE PATERSON[5] AND EQUATION DATA

Field Size, cm.	Dose in 5 Weeks		Difference
	Paterson	Equation*	
5×7	6,000	5,840	− 3%
10×15	5,000	4,190	−16%
10×20	4,000	3,920	− 2%
20×30	3,000	3,050	+ 2%

TREATMENT THROUGH "SMALL FIELD" *i.e.*, $r=3$ cm.

Duration Days	Dose		Difference
	Paterson	Equation*	
1	2,000	1,980†	−1%
4	4,000	3,640	−9%
18	5,500	5,310	−4%
32	6,000	6,090	+2%

* Equation (2).

† Using $t=0.35$ for one treatment, as established by Strandqvist.[6]

and because dosage is stated at a point, not in relation to the entire volume, we see that tolerance dosage and volume do not vary reciprocally. Instead, dosage is regulated (4) to furnish equal moments of radiation, by which we denote equal products of dose (in roentgens), depth dose (decimal fraction of the surface dose), and corrected depth. This will be true whether a single field be used or whether multiple fields share the dose in cross-fire. As a matter of fact, with cross-fire greater uniformity in the spatial distribution is attained because complementary doses tend to balance inequalities in proportional scatter. In general, when dosage in the deeper zones is adjusted in accordance with the volume factor $1/r^c$ the spatial distribution is equivalent whatever area or depth be chosen. However, the integral doses are not equal nor is the "average dose" per cc. constant.

In the superficial zone the changed distribution makes it possible to administer greater doses of radiation but the relationship to radius is inconstant and the approach has to be empirical. However, the sensitivity of the skin usually acts as a limiting factor and, except in the neck, the difference in dosage cannot ordinarily be exploited. For practical reasons, therefore, it is probably preferable to ignore the difference in spatial distribution in the superficial zone, and to apply at all depths the dosage suited for the deeper zones.

The location irradiated does not itself change the volume distribution, unless tissue density differs markedly, as in bone, or lung; consequently, the tolerance equation applies not only in pelvic irradiation but also in other regions. Indeed, a similar relation, developed empirically, with somewhat different values for the constants, has been used in our service since 1945, and has proved a reliable guide to dosage in the treatment of lesions of all sites. Naturally, the effect on especially sensitive tissues—bone marrow, for instance—has to be taken into account, and dosage modified accordingly if conditions warrant it. It should be realized also that the equation makes no allowance for general tolerance, so we find that the tissue doses calculated for treatment with big fields in one day involve such large integral doses that if administered the constitutional effects would be unduly severe.

In order to obtain an independent check on the magnitude of the doses derived from the equation, a comparison is made in Table XXIII with the tolerance doses recommended by Paterson;[5] with one exception agreement is satisfactory.

The equation is *not* intended to apply to skin dosage, nor under circumstances that radically alter the volume distribution, as in rotational therapy, or with oblique filters, grids, etc.

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DISCUSSION

Dr. VINCENT P. COLLINS, Houston, Texas. In 1943 Dr. Garcia assessed the results of treatment of 181 cases of cancer of the cervix in the first three years of the program for this disease in the Department of Radiology at Charity Hospital in New Orleans. At that time the impression was that the doses tolerated in the paracervical region were far in excess of the quantities required to obtain the maximum beneficial effects with the factors employed. It seemed unlikely that the results of treatment in Stages I and II could be materially improved. The problem seemed to be one of better defining the minimum effective dosage levels so that the doses could be reduced without diminishing the effectiveness of treatment.

The present paper represents ten further years of accumulated evidence and considered evaluation of the problem. Evidently tolerance to radiation has not been a primary problem since the evaluation of results is solely on the basis of survival. As it develops, improvement has been possible in Stages I and II as indicated in Table XX which shows a comparison of two successive five year periods. The problem of defining the minimum effective dose has resolved itself into the conclusion that for Stages I and II, at least, higher paracervical doses have proved more successful but this can be jeopardized by pressing the parametrial dose of roentgen radiation beyond 3,400 r.

It seems to me that there are four features that might be examined critically. These might be clarified by elaboration or explanation.

1. The graph showing the regression line for carcinoma of the cervix is calculated on the basis of 275 survivors. It is stated that the equation $D = Kt^m$ is empirical but the justification for the equation, and its values for K and m, would be greatly strengthened if failures as well as survivors were plotted. As presented we do not know that these survivors are in an optimal zone between excessive and inadequate treatment. Failures may fall along the same line as survivors. Treatment policies in different centers vary greatly in technique and dose employed. There are some survivors by any method of treatment. If only survivors are considered, a regression line could be plotted for either high dose policy or low dose policy. The equation for the line, and the numerical values which would result, would differ widely. Plotting the cases of high dosage complications, and of low dosage failures, would confirm the optimum regression line and have a very practical application.

2. In Table VII survival rates are carried to six significant figures. This implies a validity that is greater than that usually to be expected of even rigidly controlled laboratory experiments.

3. It is shown that in Stages I and II, increasing the dose of parametrial roentgen irradiation is associated with a diminished survival rate. Apart from the practical caution that this advises, one is interested in the explanation for this observation. The cause of death in the failures might be due to complications of high dose effects, to persistent local disease, to distant spread of metastases, or to any combination of these. If an appreciable number of failures results from high dose effects, but without persistent disease, the problem is to weigh the risk of complications against the risk of persistent disease. If failure results from persistent disease despite higher doses, this offers support for the concept of a supralethal dose. If failure results from distant metastases, no variation in the dose of local treatment will affect the outcome.

4. The terms "paracervical dose" and "parametrial dose" are used, and Manchester points A and B are recognized, but the relationship is not clear. The paracervical dose is apparently obtained by the addition of an adjusted gamma roentgen dose, and the dose in roentgens administered by external roentgen therapy. If the point at which this is calculated coincides with point A, then in some instances it will be entirely due to radium dose since point A will be shielded when a 6 cm. wide midline area is protected. If it coincides with point B at the lateral pelvic wall the contribution of radium will be minimized and roentgen radiation will contribute chiefly to the total.

These questions or criticisms are put forth as sincere inquiries because I believe this paper represents a major contribution, not only to the treatment of cancer of the cervix but to the practice of radiotherapy. It is known, but not widely enough appreciated, that the expression of dose in roentgens alone is meaningless.

Considerations of time, and of volume and area, must be included in assessing both radiation effect and tolerance. Information relating dose, time and area is available for skin, and many have apologetically extrapolated these data to the treatment of deeply situated lesions. The accumulation of dependable data, and its thoughtful analysis since 1938 by Dr. Garcia, has provided a basis for relating dose and time to survival in cancer of the cervix. This may well offer direction and guidance to the treatment of this disease for many years to come. In these days of improved techniques and supervoltage equipment, there is a tendency to seek improvement in results in higher and higher doses. We are cautioned that there is an optimum dose beyond which survival rate may be diminished.

Dr. Garcia (closing). Dr. Collins' remarks are sincerely appreciated. Concerning the results in Stages I and II the conclusions in our previous report are confirmed in the main. With a larger group of cases it has been possible to show that in Stage II the paracervical doses should be somewhat higher than we formerly believed; still in neither stage is it necessary to administer maximum dosage. In the period 1941–1945 the parametrial dosage was higher than in the years before or since. As a consequence the results in Stages I and II were better in our earlier report, which covered the years 1938–1939, and also in the more recent cases shown in Table XX. Thus the improvement should be ascribed principally to the avoidance of high parametrial dosage.

We have employed survival as the sole criterion of efficacy because we are convinced that high rates of recovery and of serious complications are inimical. Comment on the other points he raised follows.

1. In order to facilitate its evaluation, Dr. Collins recommends plotting the failures and the high dose effects, as well as the recoveries in the diagram illustrating the regression line for paracervical doses. But we fear that with 703 cases confusion rather than clarification would ensue. However, there is no question concerning the importance of properly interpreting the regression line, and we would like to dwell on it. It is well known that in attempting to control tumors by irradiation the doses tend to become larger as treatment is prolonged; to each time interval there corresponds. not a single dose, but a characteristic range of doses, which can be identified by their average and by a description of their distribution. Since our knowledge of recovery is meager a rational equation showing the relationship of dosage and time cannot be developed. Instead, we must choose some simple mathematical expression to represent the trend in an approximate way. The information suggests that with a large number of observations the plot of the average doses would very nearly describe a parabola, and statistical tests support the impression. For these reasons a parabolic curve has been selected to represent the time-dose relation. Since the number of observations is limited, a reliable method of estimating the average doses is needed. The statistical procedure of calculating the regression line is available for the purpose; it obtains the most probable values of the average doses that in accordance with the observations correspond to various periods of treatment. The regression line therefore provides the best possible estimate of the averages from the doses received by the survivors. To determine whether or not the average doses should be considered optimal other information must be supplied. We have shown that with the stage distribution in our cases the regression line gives dosage associated with median survival in all stages combined. But tabulation of the results in relation to various dose levels demonstrates that 50 per cent recovery is not the maximum that can be attained, since increasing the doses beyond the averages leads to greater survival rates. Yet some tumors require doses that lie beyond the tolerance of normal structures; consequently at all feasible dose levels some failures will always occur. It has also been shown that with any particular dose all tumors do not give equal rates of control; their size and other characteristics create differences in response. In some, nearly 100 per cent control can be obtained with relatively low dosage, while in others we must be content with a more modest yield even if the highest safe doses are administered. It constitutes a great advantage that some of the tumors whose sensitivity lies in the lower segments of the effective range can be recognized clinically. In view of these facts, treatment should not be anchored to any fixed dose level but, on the contrary, adjusted as well as possible to the features present in the individual case. It follows also that the regression line does not give optimal dosage; but it remains useful nevertheless since in the proper evaluation of

dosage a knowledge of the averages is essential, and the regression line is intended to provide them. In a representative sample the average doses should produce 50 per cent survival. This criterion is met by the dosage stated in the calculated regression line, but it is inconclusive, since there are no standards by which we may judge the composition of our sample. We must therefore rely on the size of the sample to gauge the dependability of the estimates, and it has been pointed out that they are still subject to an appreciable error. Consequently more data need to be accumulated to achieve a more precise definition of the true central values, as well as an exact description of the range, so that the probability of recovery associated with various dose levels may ultimately be stated with confidence.

2. In Table VII the survival rates were calculated to six significant figures simply to permit the application of an accurate test of significance. The rates used for the calculation were unwittingly incorporated in the table submitted to Dr. Collins, and he is correct in saying that the implication of extreme precision is false; however, it was not intended, and we are obliged to him for the elimination of the error.

3. High parametrial dosage reduces significantly the survival rates in all stages, but we are unable to give a satisfactory explanation of the mechanism involved. The cases with higher parametrial dosage had a higher incidence of radiation complications and of late sequels, but the fatalities that occurred can account for only a very small part of the difference in the results. Nor was the incidence of failures due to metastases changed appreciably. As in other series, the majority of the failures must be attributed to recurrent or residual disease in the pelvis.

4. The text submitted to Dr. Collins failed to make clear that by paracervical and parametrial doses we meant the doses at points A and B respectively. Dosage at both points has gamma- and roentgen-ray components. Even with a 6 cm. separation of the anterior and posterior fields the contribution from roentgen radiation at point A is significant, since it receives direct radiation from the lateral fields plus scatter from the other four. Point B received 1,000–2,500 r of gamma radiation, which cannot be considered negligible, we believe, even when corrected for quality.

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THE CHEMOSURGICAL METHOD FOR THE MICROSCOPICALLY CONTROLLED EXCISION OF RADIORESISTANT FACIAL CANCER*

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FACIAL cancers which have proved to be radioresistant, either by reason of biologic resistance or by reason of unrecognized "silent" extensions, often are amenable to chemosurgical treatment. This relatively new surgical technique[1] achieves complete microscopic control of excision by a procedure which includes three steps: (1) chemical fixation of the tissues in situ, (2) excision of a layer of fixed tissue and (3) systematic microscopic examination of frozen sections as a guide to further treatment. The microscopic guidance makes it possible to accurately follow out extensions which otherwise might go unrecognized because of their small caliber or because of their being obscured by scar or other indurated tissue. The method is of particular value in recurrent neoplasms which may be reliably, yet conservatively, removed with practically no operative risk.

The chemosurgical technique was worked out in rats.[2] The chemical chosen for fixation in situ was zinc chloride, a caustic agent long used for the destruction of cancer tissue, mostly by unethical practitioners who, of course, had no thought of subsequent excision let alone of excision under microscopic control. This chemical, when incorporated in a suitable paste vehicle, was accurately controllable, produced adequate fixation and was nontoxic. Animal experiments demonstrated that chemical treatment had no tendency to increase the incidence of metastasis; in fact, the opposite was true. This conclusion has been confirmed by the clinical experience with more than 4,000 patients treated by this method during the past seventeen years.

TECHNIQUE

The technique may be described by the use of a diagram showing a cancer with three slender downgrowths (Fig. 1*A*). The main mass may either be surgically excised under local anesthesia or it may be excised after a heavy application of the fixative paste. After removal of the main mass the

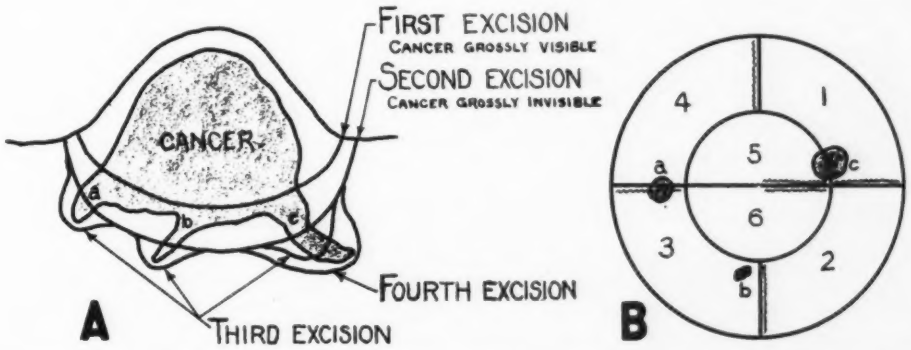

FIG. 1. Diagrams showing the technique for locating cancer microscopically during the course of extirpation. The stippled areas represent cancer. (*A*) Side view of the neoplasm, showing deep extensions (*a*, *b*, and *c*), and the four planes of incision. (*B*) Top view of the second excised layer, showing how the deep extensions (*a*, *b* and *c*) are located microscopically by examining frozen sections made by cutting through the undersurface of each specimen. In this example four excisions were required to reach a cancer-free plane.

* From the Chemosurgery Clinic, Department of Surgery, University of Wisconsin Medical School, Madison. Presented at the Thirty-fifth Annual Meeting, American Radium Society, St. Louis, Mo., April 20–22, 1953.

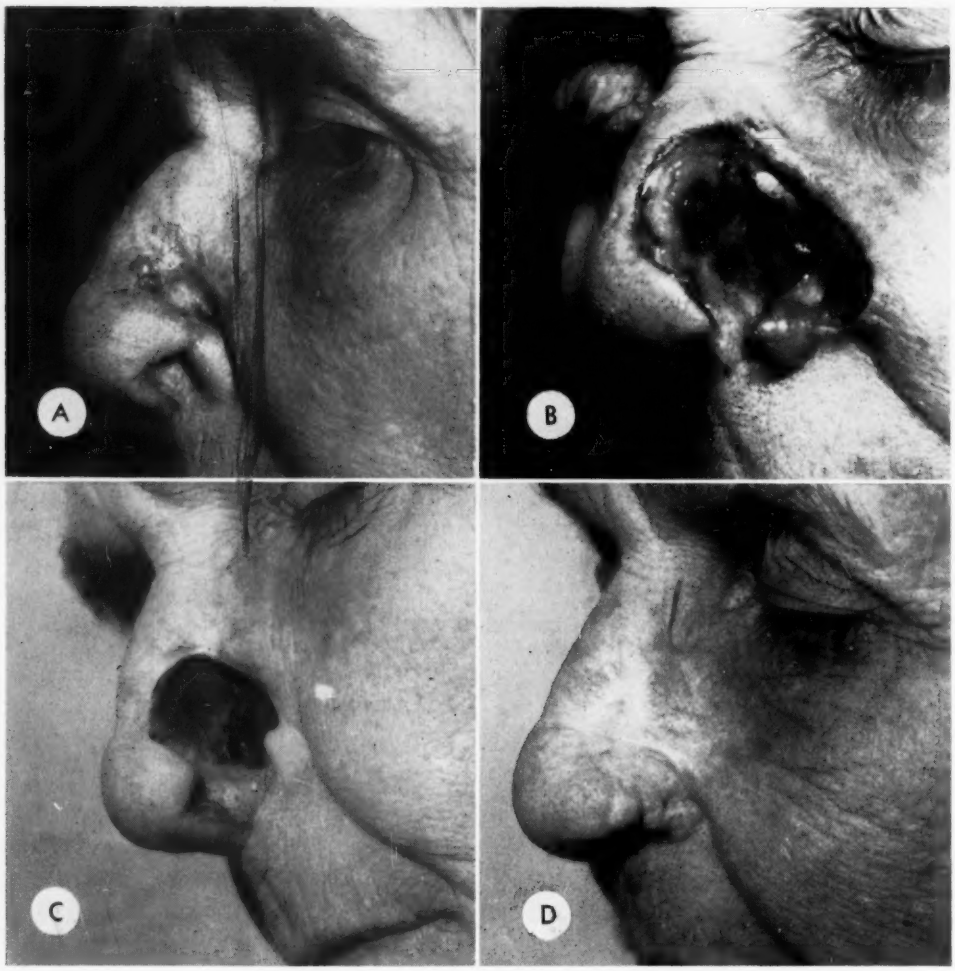

FIG. 2. (*A*) Basal cell carcinoma which arose on the nose adjacent to the nasolabial fold and which had recurred after three treatments with electrodesiccation and fifty treatments with roentgen rays over a period of eight years. It was excised in six microscopically controlled stages (see Fig. 3). Besides involving the entire ala the cancer extended around the edge of the nasal bone and deeply into the embryologic fusion plane in the nasolabial fold region. (*B*) Granulation tissue and edge of nasal bone after chemosurgical excision. (*C*) Healed lesion. (*D*) Repaired lesion. The well vascularized tissues lent themselves well to plastic repair. The patient was free of cancer after twelve years.

fixative is applied in a thickness sufficient to penetrate 2 or 3 mm. so that a layer of fixed tissue may be excised several hours later. This excision is made through fixed tissue so there is no pain or bleeding unless the incision inadvertently is carried too deeply. Since the extensions (*a*, *b*, and *c*) are too slender to be grossly discernible, the excised layer is divided into six specimens of convenient size, and frozen sections are cut through the undersurface of each of the flat pieces of tissue. The locations of the microscopically demonstrated downgrowths are marked on a map on a pad of paper (Fig. 1*B*). This map corresponds to the lesion on which the origin of the specimens also is indicated by marks with mercurochrome. Reapplication of the fixative is limited to the cancerous areas and the process repeated until a completely cancer-free plane is reached. After a week the final layer of fixed tissue separates and the lesion heals rapidly, forming soft, smooth scars of surprisingly good appearance.

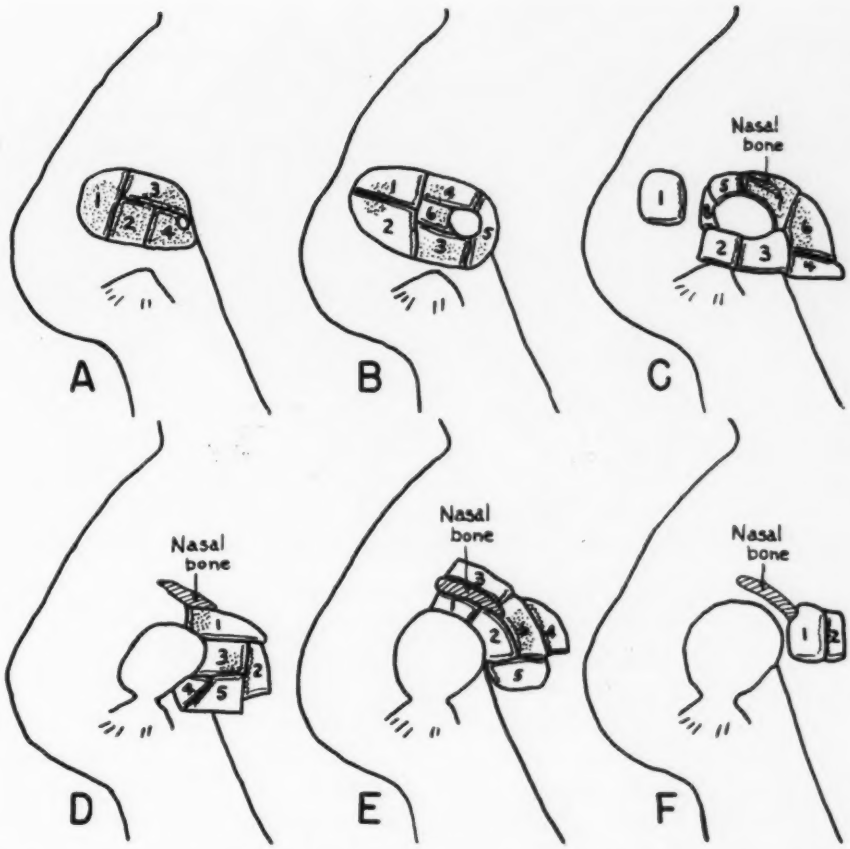

Fig. 3. Maps showing the locations of the specimens removed from the lesion in Figure 2 during six successive excisions. The stippled areas represent cancer located by microscopically scanning the frozen sections made through the undersurface of each specimen.

The method can be used for the treatment of cancer on the external surface or in cavities sufficiently accessible for the multiple-stage procedure. This article is limited to facial cancers which have recurred after irradiation.

CANCER OF THE NOSE

Cancer of the nose[3] often sends out small caliber extensions which are difficult to detect by clinical examination because the consistency of cancer is similar to that of the fibrocartilaginous tissues of the nose. The treacherousness of nasal lesions is most often manifested in the region of the nasolabial fold where basal cell carcinomas are prone to be highly invasive and where they often extend deeply along the embryologic fusion plane in this region (Fig. 2). In more advanced cases strands and sheets of cancer may extend widely and be deflected in an irregular and unpredictable manner by bone and cartilage (Fig. 4). The silent extensions may be particularly unsuspected in cases in which the more superficial portions of the neoplasm have been kept under control by radiation or surgical measures. The complete microscopic control of excision afforded by the chemosurgical method makes it possible to selectively follow out each extension and to preserve the uninvolved tissues.

CANCER OF THE EAR

Because of the thinness of the tissues overlying the cartilages of the ear most cancers reach the cartilage at a relatively early stage. Although cancer spreads readi-

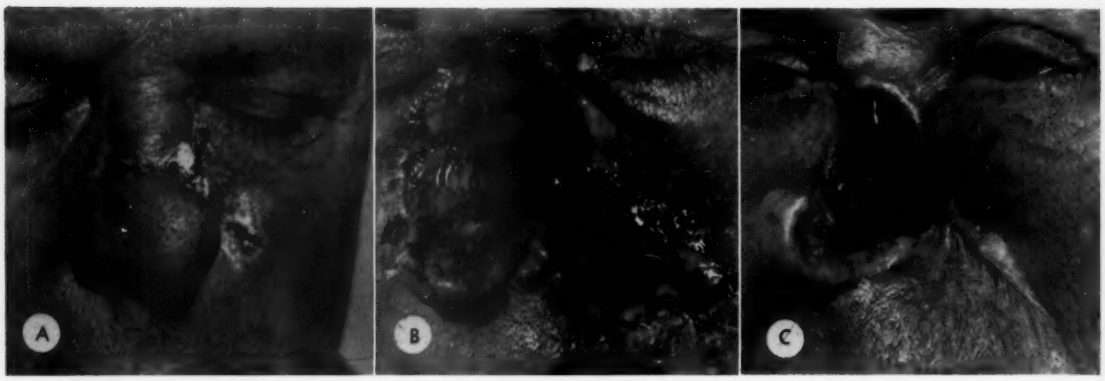

FIG. 4. (*A*) Basal cell carcinoma which originated in the nasolabial sulcus and continued to spread despite electrosurgical excision, treatment with radium plaques, roentgen rays and radon seeds, and finally, surgical excision and plastic repair at a noted cancer hospital. (*B*) Granulation tissue after chemosurgical excision of the cancer which extended unexpectedly along the periosteum at the root of the nose, and also into the nasal cavity and out into the cheek. (*C*) Healed lesion. A plastic reconstruction was done later. There was no recurrence after twelve years.

ly along the perichondrium it usually does not penetrate cartilage until the neoplasm has become advanced. This circumstance facilitates chemosurgical treatment since it is necessary simply to remove all tissues down to the cartilage and then carry fixation peripherally until noncancerous sections are obtained.[4] A layer of cartilage is removed with the final layer of fixed tissue and healing usually takes place with little defect (Fig. 5)

Some cases of cancer of the ear may fail to respond to radiation therapy because of (1) biologic radioresistance, (2) the inadvisability of heavy dosage owing to the vulnerability of the adjacent cartilage or (3) the presence of unexpected outgrowths which often extend for a considerable

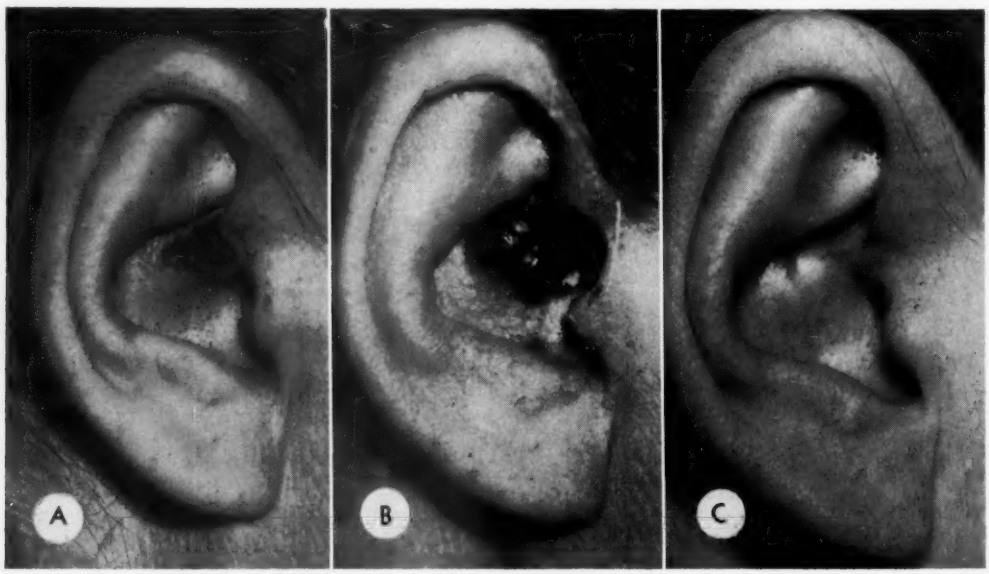

FIG. 5. (*A*) Keratinizing type of basal cell carcinoma which appeared to be localized to the inferior crus. The neoplasm had recurred after three roentgen treatments, surgical excision and electrodesiccation. (*B*) Granulation tissue after chemosurgical excision of the cancer which followed the perichondrium down into the concha. (*C*) Healed lesion. There was no recurrence after three years.

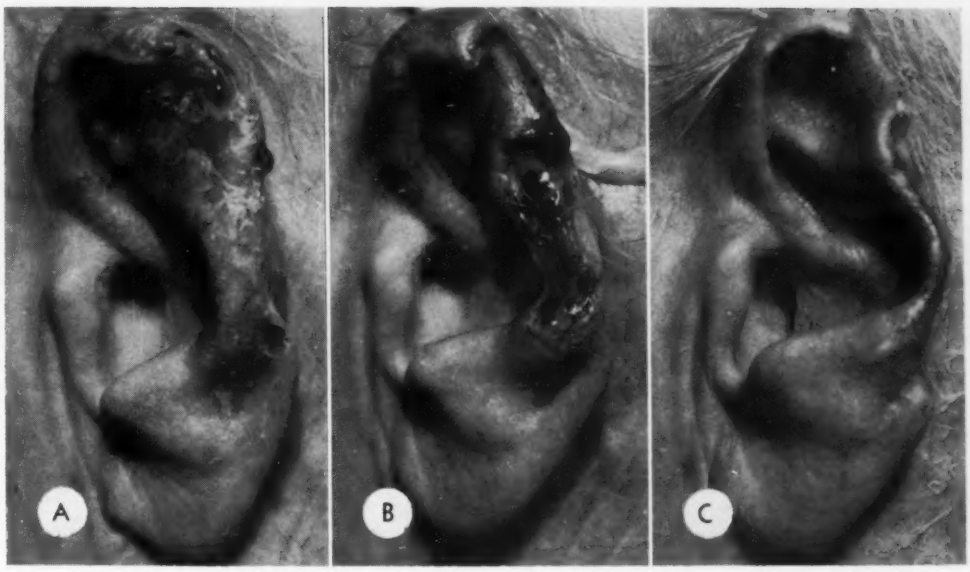

Fig. 6. (*A*) Mixed squamous and basal cell carcinoma which had persisted along the helix in spite of two series of roentgen therapy and one radium application. Besides this there also was a painful perichondritis and radionecrosis of four years' duration. (*B*) Lesion at completion of chemosurgical excision. (*C*) Healed lesion after chemosurgical excision. There was no recurrence after six years.

distance along the perichondrium or other tissues. The chemosurgical method is useful not only in eradicating the residual cancer in such cases but also in eliminating cartilage and other tissues which have been damaged by the radiation (Fig. 6). The conservatism which can be practiced safely with the chemosurgical technique often allows preservation of so much of the tissues of the ear that a repair is either avoided or made relatively simple.

CANCER OF THE EYELID

Cancers of the eyelid, particularly those in the inner canthus, may at times prove to be difficult therapeutic problems.[5] Experience in the chemosurgical treatment of inner canthal lesions has revealed that many of the recurrent lesions extend rather deeply along the periosteum of the medial wall of the orbit (Fig. 7). Fortunately, the sheets of cancer usually remain close to the orbital walls for a long time, making it possible to follow them out with the chemosurgical technique without damage to the eyeball. Only if the carcinoma has eroded into the sclera is it necessary to remove the eyeball.

CANCER OF THE OTHER AREAS OF THE FACE

Cancers of the nonorificial portions of the face[6] are less likely to resist radiation treatment than are those of the nose, ears and eyelids. However, when facial cancers do recur they may be removed readily by means of the chemosurgical technique even though they may be rather extensive (Fig. 8). Facial carcinomas, especially recurrent ones, often exhibit unexpected outgrowths from the main mass. For example, many of the more highly invasive basal cell carcinomas of the forehead, temples, or scalp show a strong tendency to extend peripherally for an unexpectedly great distance in the dermis (Fig. 9).

CANCER OF THE LIP

Squamous cell carcinoma of the lip occasionally recurs after surgical excision and radiation therapy (Fig. 10). These recurrent neoplasms respond well to chemosurgical treatment.[7] Not infrequently there are irregular extensions which, in some cases, extend unexpectedly into the submucosa at the periphery while in other cases

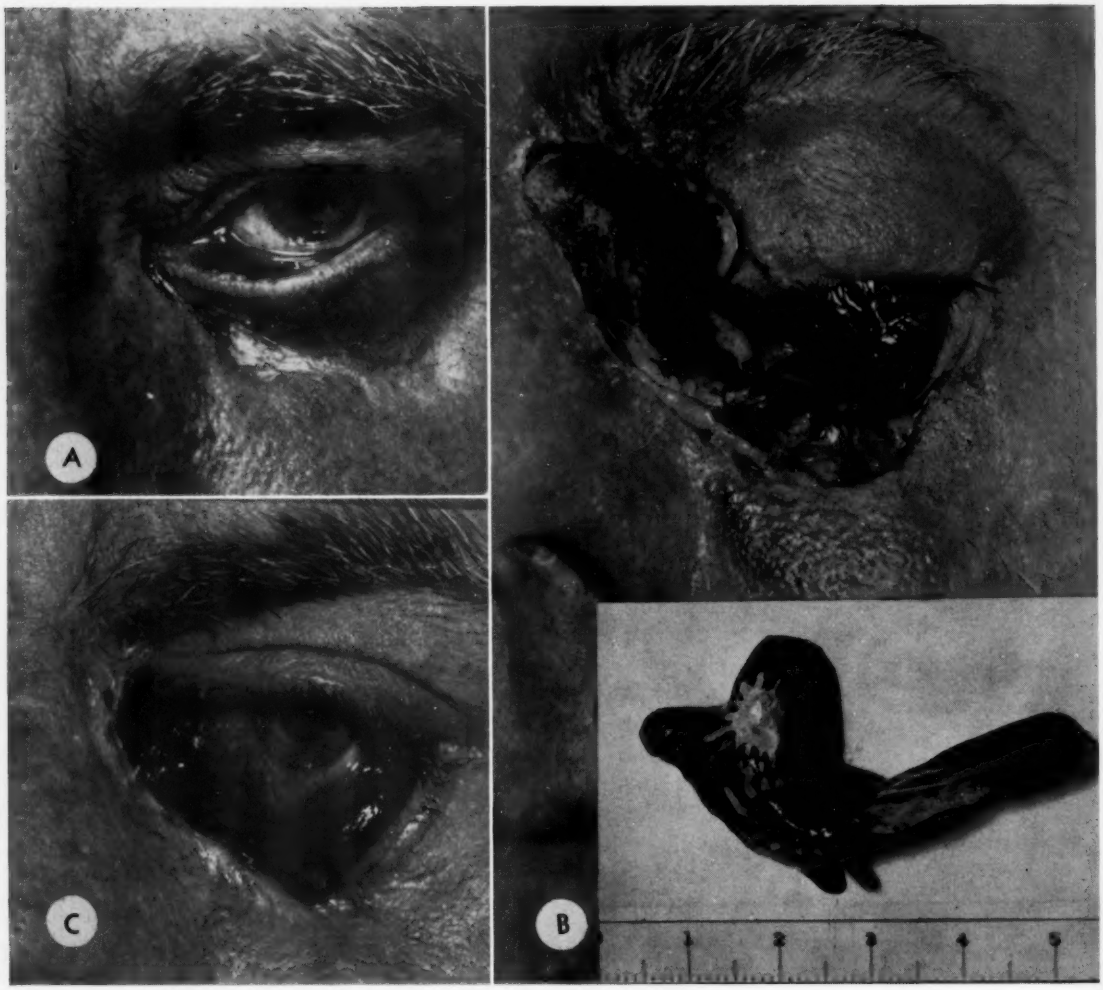

FIG. 7. (*A*) Basal cell carcinoma in the medial canthal region. The superficial part of the neoplasm had been kept in check for ten years by treatment with radium and surgical excision. (*B*) Lesion at completion of chemosurgical excision. The extent of the cancer is indicated by the reconstruction. Besides the shelf of cancer extending along the inferior and medial walls of the orbit there were extensions into the upper eyelid, into the periosteum of the nasal bone and into the fossa of the lacrimal sac. (*C*) Defect after healing. The binocular vision was unimpaired. The defect was repaired later. There was no recurrence after fifteen years.

they may take the form of downgrowths along either the anterior or posterior surface of the orbicularis oris muscle. Some cancers selectively follow nerve sheaths for considerable distances, occasionally even to the mental foramen.

Because of the microscopic control the primary neoplasm can be chemosurgically excised with great assurance of complete eradication. Yet the amount of destruction of the labial tissues is so minimal that only rarely is a repair necessary.

As with squamous cell carcinoma elsewhere there is a possibility of regional metastasis. If the lymph nodes are involved a surgical neck dissection is indicated. In the absence of enlargement of the lymph nodes, a prophylactic neck dissection is recommended only when the large size or high grade of malignancy of the primary lesion makes it seem fairly likely that metastasis may have taken place.

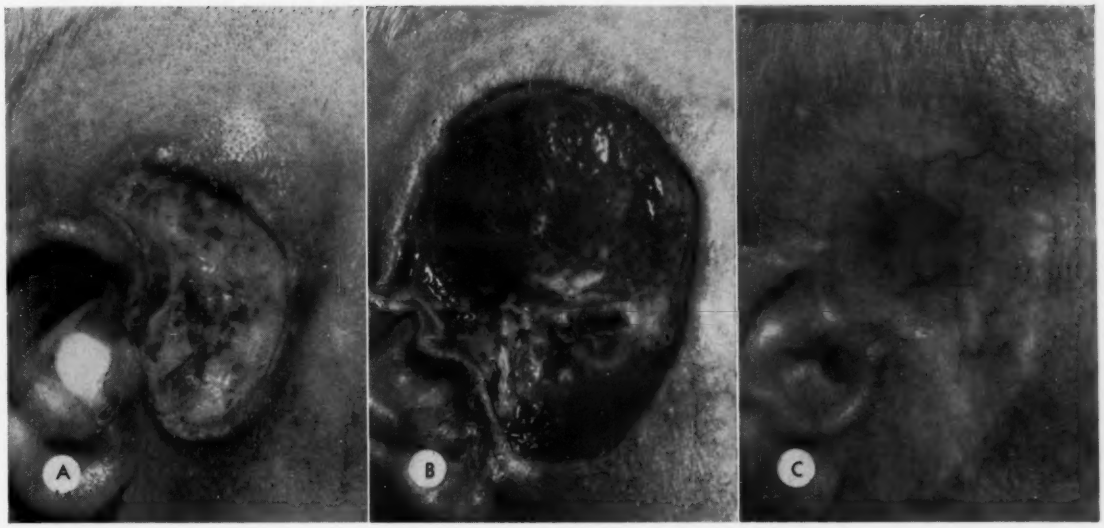

Fig. 8. (*A*) Squamous cell carcinoma, Grade 3 malignancy, which had recurred after two series of radium treatments and two series of roentgen therapy. The lesion was considered inoperable by several competent surgeons. (*B*) Granulation tissue after chemosurgical excision. The upper part of the parotid gland and part of the temporomandibular joint were removed without complication except for paralysis of the branch of the facial nerve that supplies the forehead. (*C*) Healed lesion. There was no recurrence after ten years.

DISCUSSION

The chemosurgical method is particularly advantageous for the removal of carcinomas which have recurred after radiation therapy not only because biologic radioresistance has no effect on the response to chemosurgical treatment but also because the microscopically guided chemosurgical technique makes it possible to selectively follow out the "silent" extensions which often are observed in association with these refractory neoplasms. The reasons for the frequency of these unexpected outgrowths in radioresistant neoplasms are twofold: first, the radiation may eradicate the more superficial portion of the cancer and leave

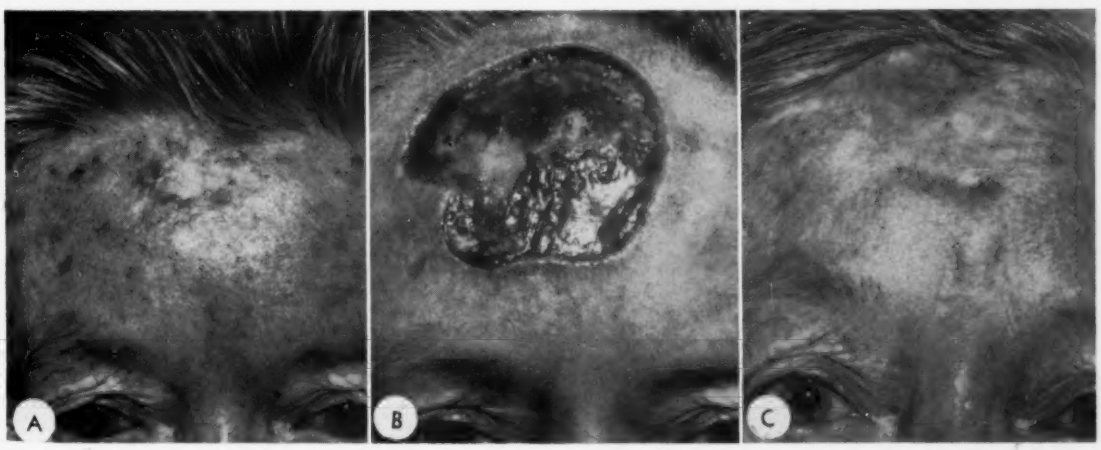

Fig. 9. (*A*) Basal cell carcinoma which had recurred after electrodesiccation and after two courses of roentgen therapy. (*B*) Granulation tissue after removal by means of nine microscopically controlled chemosurgical excisions which revealed irregular peripheral extension in the dermis for as much as 3 cm. beyond the clinically detectable edge of the neoplasm. (*C*) Healed lesion. There was no recurrence after six years.

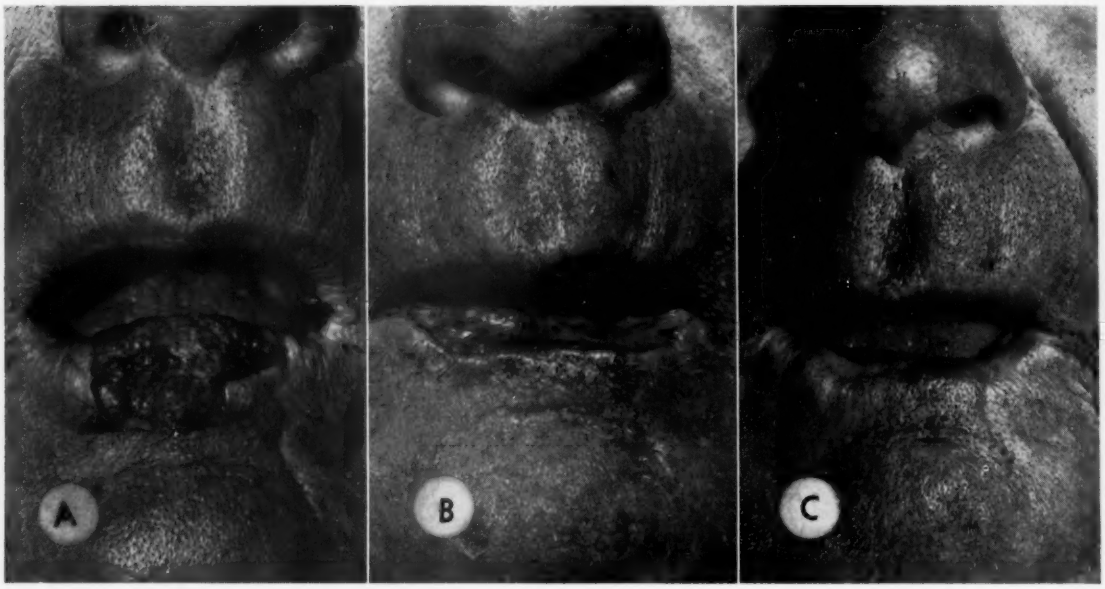

FIG. 10. (*A*) Squamous cell carcinoma, Grade 2, which had recurred after V-excision and postoperative roentgen therapy two years previously. The patient believed that the lesion was a recurrence but it may have been a new primary lesion. (*B*) Granulation tissue after chemosurgical excision. (*C*) Healed lesion. There was no recurrence after ten years.

the deeper portion to spread undetected under cover of the overlying scar tissue; second, the radiation, especially if oft-repeated, may cause an increase in malignancy with resultant augmented power to send out silent extensions of cancer into the surrounding tissues.

Some of the slender strands and thin sheets of cancer which grow out from the main mass may follow specific structures such as the dermis, fascial planes, periosteum, perichondrium, embryologic fusion planes, nerve sheaths, lymphatic vessels or blood vessels. In other cases, the cancer exhibits no specific affinity for any particular tissue but nevertheless develops irregular, clinically undetectable outgrowths, apparently as a result of the countless variations in the mechanical and nutritive conditions which affect the spread of cancer.[8]

Though patterns of spread may be discerned for given types of tumor in given regions, every neoplasm has its own indi-

TABLE I

FIVE YEAR END RESULTS OBTAINED BY CHEMOSURGICAL TREATMENT OF CUTANEOUS CARCINOMA AS COMPARED WITH THE RESULTS AT THE RADIUMHEMMET[9]

	Total Cases	Determinate Cases*	Rate of Cure
Basal cell carcinoma, present series	1,071	782	98.2
Basal cell carcinoma, Radiumhemmet	553	272	88.2
Squamous cell carcinoma, present series	483	356	84.8
Squamous cell carcinoma, Radiumhemmet series	174	91	65.9
Basal and squamous cell carcinoma, present series	1,554	1,138	94.0
Basal and squamous cell carcinoma, Radiumhemmet series	727	363	82.6

* Determinate cases include all but patients who died of intercurrent disease without recurrence or were lost from observation without recurrence before the lapse of five years.

vidual behavior pattern and there is no way of predicting whether or not it will follow the usual trend. The systematic microscopic guidance of excision provided by the chemosurgical technique affords a reliable means of determining just how far and in what direction a given neoplasm has spread. By this means excision may be radical where the extensions are found to have spread widely and conservative where no unpredicted outgrowths are present.

The reliability of the chemosurgical method is attested by the statistical results as presented in a forthcoming monograph on chemosurgery.[9] The five year rate of cure attained by chemosurgical treatment of a consecutive series of 1,554 patients with cancer of the skin was 94.0 per cent as compared to the next best rate of 82.6 per cent as reported by Magnusson[10] on a similar series of cases at the Radiumhemmet (Table 1). More recent but less detailed statistics on 6,128 cases reported from the Radiumhemmet reveal a five year cure rate of 87.6 per cent.[11]

Besides the reliability and conservatism attainable with the chemosurgical method there is the advantage of an extremely low operative mortality rate, owing in part to the fact that no general anesthetic is used. In the series of 1,554 cases of cancer of the skin there were only 4 deaths during chemosurgical treatment (0.26 per cent). Of these deaths only 1 was attributable to the treatment; the others were due to intercurrent disease.

The chemosurgical procedure is a specialized one which requires special training not only in the operative technique but also in the interpretation of the microscopic sections. Facilities and trained personnel for making the special type of frozen sections also are necessary.[12] Eventually such a setup should be available in every large center of population.

CONCLUSIONS

The chemosurgical method is particularly advantageous for the removal of radioresistant facial cancers because the complete microscopic control of excision makes it possible to destroy not only the main neoplastic mass but also the "silent" extensions which are frequently observed in recurrent lesions. The microscopic guidance not only results in a high degree of reliability but it also makes conservatism safely possible. The operative mortality is very low because no general anesthetic is used.

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BIOLOGICAL MODIFICATION OF EFFECTS OF ROENTGEN RAYS*

I. REDUCED TEMPERATURE

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THE writer's interest in radiology has arisen from two lines of investigation. (a) Since temporary local ligation can cure tumors under certain conditions[1], observations were published on the accessory influence of roentgen rays.[2] (b) Temperature strongly influences shock, tissue preservation and physiological processes in general;[3] therefore, a further investigation of the relation with radiation seemed desirable. There is agreement in the literature on the broad principle that heat and all other agencies causing hyperemia or inflammation sensitize to radiation. The highly conflicting literature on the influence of cold will be partially reviewed and discussed later.

EXPERIMENTAL MATERIAL

The present experiments were performed on rats, mostly of Sherman strain, ranging in age and size from 90 to 300 grams. Closely comparable individuals were used for tests and controls, but results in different groups were essentially similar. All animals were asleep under nembutal when irradiated. Treatments were given with constants of 200 kv., 15 ma., filtration of 0.5 mm. Cu and 1 mm. Al, and target distance of 35 cm., which was measured to the skin in local treatments and to the estimated center of the body in systemic treatments. The dosage rate was calculated as 77 roentgens per minute in air. Generally the rats were laid on an ordinary padded treatment table. In the instances when they rested on rubber bags containing cold or hot water to a depth of about 3 cm., comparisons were made with bags similarly filled with water at room temperature. No consistent differences attributable to backscatter were noticed.

IRRADIATION OF NORMAL RATS UNDER VARIOUS CONDITIONS

Whole Body Irradiation. Leach and Sugiura[4] found that 500 r killed rats in two to eighteen days, and 700 r in six or seven days. Lethal doses for mice and guinea pigs are variously reckoned from 500 to 1,200 r,[5,6] but the figures of 1,175 to 1,500 r for fatality within two to five days are nearest to the conditions of the present experiments. Discrepancies due to secondary radiation and other physical variables, as discussed by Ellinger[6] and others, are beyond the scope of these observations, which aimed only to establish a working basis for comparing different physiological states in a limited number of animals. A few exploratory tests showed the possibility of earlier deaths from much larger doses. The doses were chosen to give sharp and regular comparisons.

Table 1 compares 24 rats in normal state, 18 with hypothermia, 9 with asphyxia, 14 with starvation and 16 with fever, with results as follows.

Rats in Normal State: The animals, under nembutal, lying on their bellies without cover or confinement, were irradiated either singly or in pairs with the 2 rats crowded closely together. No rat died from 1,000 r or survived 1,250 r. With 1,500 r death was earlier. Thus the LD_{100} was slightly less than 1,250 r. But it must be recognized that the conditions designated as normal included the reduced body temperature (sometimes below 90° F.) to which rats are subject in nembutal anesthesia, and also a possible relative hypoxia under these conditions. These physiological factors (presumably tending to increase resistance) must be considered in addition to the above mentioned radiation variables in making comparisons with unanesthetized animals of other authors.

Hypothermia: Though rats cannot tolerate

* The expenses of this investigation were paid by Mr. Sherman Fairchild of New York. Thanks are expressed to Dr. Frank K. Safford for indispensable aid throughout the research; also to Dr. Albert Richman and Dr. Charles Gottlieb for providing facilities.

Table I

WHOLE BODY IRRADIATION OF 65 RATS

Dose roentgens	Time of Survival				
	Normal	Hypothermia	Asphyxia	Starvation	Fever
1,500	(8) 3 or 5 days	(6) 5 to 7 days	(3) 5 to 7 days	(3) 2 days	—
1,250	(8) 6 to 10 days	(6) Permanent	(3) Permanent	(3) 2 to 4 days	(5) 3 to 5 days
1,000	(8) Permanent	(6) Permanent	(3) Permanent	(4) 3 to 6 days	(5) 4 to 6 days
850	—	—	—	(4) 6 or 7 days	(6) 5 to 7 days

Figures in parenthesis signify number of animals.

the prolonged hypothermia which is possible in man, they can withstand short periods of lower temperature, down to 58° F. or 14° C. From Temple Fay's experiments and German concentration camp records, the lowest limit for man has been considered to be 74° F. or 23° C. One remarkable case recently published of recovery after accidental chilling down to 68° F. (20° C.) must be classed as exceptional.[7a] In the present experiments, the anesthetized rats were cooled either by partial immersion in ice water, or in a dry state by lying on ice bags, to bring the colon temperature somewhere between 60 and 70° F. (15–21° C.). In the wet condition, a little ice might be laid alongside the body. Under the different circumstances there might be a small temperature rise during irradiation, or a fall below the critical level whereby death eliminated some rats from the series. The chilled rats uniformly withstood the 1,250 r dosage, and their survival after 1,500 r was lengthened.

Asphyxia: After earlier trials, potassium cyanide and carbon monoxide were discarded because of toxic side-effects. The usual devices for low-oxygen atmosphere being not feasible, two crude substitutes were employed. One was a thin plastic box, which was practically filled by the bodies of 2 anesthetized rats, and which could be sealed for asphyxia or left open at the sides for aerated controls. In the other method, part of a rubber glove was slipped over a rat's head and secured by a moderately tight rubber band around the neck. With either method, dyspneic breathing soon began, and preliminary trials indicated how long survival might be from this point. Since this time was not more than three to four minutes, it was necessary to interrupt the irradiation, provide brief aeration and then repeat the asphyxia until the radiation dose was completed. The later periods of asphyxia were more dangerous than the first, and the high mortality left only 9 survivors. This result corresponded with Lacassagne's observation[8] that carbon dioxide asphyxia is more often fatal than simple nitrogen asphyxia, but also more protective against radiation. Notwithstanding the severe strain on the surviving rats, they uniformly withstood 1,250 r and lived longer than the normals after 1,500 r. Since the infant rats used by Lacassagne became chilled during his experiments, the present results seem to be the first demonstration of reduced radiosensitivity with systemic asphyxia at normal temperature in mammals.

Starvation: Large strong rats were supposed to starve to within one day of death. Through miscalculation, several died shortly before treatment or failed to recover on feeding. Immediately after the radiation treatment abundant food was supplied.

Since advanced starvation reduces not only the bodily food stores but also the active protoplasm, irradiation of this reduced mass might conceivably cause less intoxication. The starvation also brings about a reduction of metabolism or oxidation which has been frequently associated with reduced radiosensitivity. Mere weak-

ness may be overcome by the eating during the period before radiation sickness becomes manifest.

The irradiated rats ate ravenously and picked up weight and strength for a day or two like the nonirradiated controls. Then the characteristic anorexia of roentgen-ray poisoning supervened, and death occurred not only with 1,000 r but also in 2 animals which received only 850 r. No attempt was made to define an actual minimal lethal dose.

The animal results have an interesting correlation with clinical remarks of Steinberg[9] on radiation sickness. "If a marked secondary anemia is present or the patient is debilitated, it is almost impossible to give an adequate dose of roentgen rays without producing one or more of the symptoms of this malady."

A smaller series tested the opposite plan of full diet up to the time of irradiation, then inanition afterward. Rats can withstand only a few days of total starvation, but after that a reduced diet was given to keep them emaciated at two-thirds or less of their normal weight for a month. This procedure did not alter the mortality. Two deductions follow. First, the vigor or vitality of the organism is one element in resistance to radiation. Second, the effects here were determined by the state of the organism at the actual time of irradiation, not by starvation or weakness during the time when the injury was becoming manifest.

Fever: An anesthetized rat is laid on a hot water bag and covered with a woollen cloth. Within ten or fifteen minutes a selected degree of colon temperature is obtainable, from 104 to 107° F. (40 to 41.5° C.). A rise as high as 108° F. (42° C.) can be tolerated only momentarily. Three different plans may then be followed. A rat with moderate fever may be laid uncovered on a moderately warm bag during irradiation, so that the fever at the end of treatment may have risen to 106 or 107° F. (or the animal may sometimes be dead from higher fever), and comparison may be made with a rat on a similar bag containing water at room temperature. Or, a rat with maximum fever may be simply irradiated, and if the room is warm the temperature at the end may be 103 or 104° F. Or, the rat may be laid between hot water bags with an edge touching each side, and with a fortunate estimation a fever of 105 or 106° F. may be maintained fairly uniformly throughout irradiation. In the absence of elaborate apparatus, these crude plans all served the purpose. All caused death with 1,000 r, and in a single trial also with 850 r, but 500 r with fever was ineffective.

These various classes of experiments were satisfactory in showing, without uncertainties or exceptions, the reduced radiosensitivity with hypothermia and asphyxia and the increased sensitivity with starvation and fever. Hypothermia and starvation both reduce metabolism but affect radiosensitivity oppositely.

Irradiation of Legs and Tails. The far higher radiation tolerance of rat tissues as compared with the human is well known. Reference has already been made to the minor microscopic changes observed in mice and other species with small doses from 50 r upward. Gall and his co-workers[10a] found minimal changes in the bone marrow of young rats with 600 r, reaching a maximum with 1,800 r. Again[10b] they gave doses of 600 to 3,000 r (200 kv., in air) to the lateral surfaces of the thighs, finding no histologic change with 600 r, trivial capillary dilatations with 1,200 r, and increasing inflammatory pictures and epilation from 1,800 to 3,000 r. Leach and Sugiura[4] fixed 10,000 r as the critical dose for the rat heart and incidentally noted the skin changes: no epilation from 750 r, transitory epilation from 1,500 r, increasing vesication from 3,000 to 7,500 r, severe ulceration from 10,000 r and local necrosis from 25,000 r.

It has been customary to fasten rats on a Y-shaped board or cardboard to irradiate one leg. The present work was done with a thin board 4 or 5 cm. wide at the rat's body and terminating in a slender end-piece where the foot and leg are fastened. The other leg and the tail are drawn up as far as possible toward the head. In this way 3 to 6 rats are irradiated simultaneously, the possible number depending chiefly on whether the feet are to be shielded with lead. Microscopic examination could not have added anything useful to the studies already in the literature, but the gross observations can add some details concerning the rat's tissue tolerance.

Normal Rats: The epilatory dose of 1,050 r[4] applies to the tender skin of the ventral surface, but it has no gross effect on the thick skin of the back or the outer thigh. As previously stated,[2] the foot with its delicate skin is easily vulnerable, and marked vesication occurs with 3,000 r, more severe vesication and ankylosis of the ankle with about 3,500 r (with excess damage to toes), and loss of the foot and lower leg with

4,000–4,500 r. Groups of the present experiments have been performed with or without shielding of the foot, one item of consideration being that lowered resistance sometimes allows destruction of the entire leg by ulceration extending from the foot, when it would not result from irradiation of the upper leg alone. The upper thigh survives as much as 6,000 r., though the vesication requires months to heal and much damage to skin and deep tissues remains. Only a few higher doses, up to 7,500 r, have been tried in this series, and the destructive and toxic effects indicate that dosage of 10,000 r and upward can be feasible only for very small areas where tissue can fill in from the sides.

The tail is characterized by thick tough skin and a long tenuous vascular supply. The skin itself is rather sensitive compared to that of the outer thigh, for it begins with erythema at about 3,000 r and becomes vesicated and crusted at about 3,500 r. Sometimes with this dose, and certainly with 4,000–4,500 r, mummification occurs and the tail is lost, the lower tolerance as compared with the leg being presumably due to the vulnerable blood vessels.

Refrigeration: The peripheral tissues of adult animals and man tolerate periods of near freezing temperature such as Evans[11] applied to the entire bodies of newborn rats. In the present experiments, the anesthetized rats were chilled in ice or ice water to a body temperature slightly below or above 65° F. (18° C.), as previously described. A sheet of rubber dam was spread on the usual table, and a hindleg was laid on this with small pieces of ice adjacent to it, with the result that the lower surface of the leg rested in a thin layer of ice water. In some tail experiments the procedure was similar. In other groups the tail alone was thus chilled and not the body, to test possible systemic influences. In a few instances the tails were cooled on ice bags as controls for the factor of wetness.

With any of these methods the results were not uniform. There had been quite a strong anticipation, based partly on the experience with surgical shock and partly on the publications of Evans and others, that the protective action which was evident with systemic hypothermia would be still greater with the more radical local refrigeration. This had been expected to be the principal part of the investigation, and careful day-to-day records were kept of over 100 rats, not counting deaths and other accidents, in the attempt to reach a conclusion or explanation. An increase of radiosensitivity by cold was not indicated, the instances of stronger effect in the chilled rats as compared with controls being so few as to be accounted accidental. In some instances a protective action of cold seemed quite pronounced. In other instances there was no difference as compared with controls in other animals or the same animal. For example, 1 rat weighing 220 gm. was given 4,000 r on the right hindleg on May 8 at normal temperature. On May 29, weighing 230 gm., it received the same dose on the left hindleg with refrigeration. The time and degree of vesication and the subsequent degree of permanent epilation were indistinguishable in the two legs.

The dosage was graded from 3,000 to 7,000 r, to judge minimal or maximal effects and gradations between. Besides the above mentioned comparisons with and without systemic chilling, the local chilling was made either milder or more radical. Animals which were waking at the end of irradiation were compared with others which were so nearly dead that they had to be revived in warm water. Besides rapid and slow re-warming, there were tests of several hours of refrigeration either before or after the irradiation. The conditions involved a long and tedious transportation of the rats from one institution where they were kept and prepared, to the other institution where only the roentgen-ray apparatus was available. These conditions not only cost much effort and time but also precluded any studies of circulation, oxygenation or other physiological details, or any such fine temperature distinctions as those between 0 and 6° C. which Mottram found significant. The observed variations did not permit of any intelligible tabulation or interpretation, and an explanation evidently lies in those finer features which could not be defined or controlled. There is also the previously mentioned question whether anesthesia resulted in hypoxia which reduced the difference between cooled and concontrol animals.

Three legs treated with tourniquet and refrigeration seemed to show no protection, but the attempt was abandoned because of the technical difficulty of giving equal irradiation to several chilled and ligated legs simultaneously. Ten tails ligated and refrigerated gave evidence of quite marked protection, in that doses from 3,500 to 4,500 r showed only slight effects and those of 5,000 r and in one instance 6,000 r caused only glazing and sclerosis instead of the usual mummification and self-amputation.

These findings were more impressive because the ligated tails were not treated as a group but were interspersed singly among the nonligated groups and therefore subject to the same technical irregularities. As shown in previous work,[12] the rat's tail readily approximates the temperature of its environment, especially the distal half or two-thirds, to which the irradiation was limited in these experiments. Thus, the ligated tails probably did not differ greatly in temperature from those with refrigeration alone. Any suspicion of cold-injury of tissues is thus excluded, and the main impression is confirmatory of Mottram's idea of anoxia.

Besides any cooling of the body, the legs and tails always received extra chilling; and in retrospect it might have been desirable to test the sensitivity of these peripheral parts with merely the degree of hypothermia which had proved protective against whole body irradiation. The nearest approach was in 3 rats, which in hypothermia for another purpose happened to receive respectively 1,500, 2,000 and 2,500 r on the delicate skin of the rear part of the abdomen. They showed distinctly less vesication than 6 rats similarly irradiated at normal temperature. Though suggestive, the number is too small for decision. In regard to surgical shock, the intestine of the rat (but not of cat or dog) reacts to cold oppositely from the peripheral tissues;[13] therefore, it is conceivable that the influence of cold on radiosensitivity may not be the same for viscera and peripheral parts. Furthermore, in whole body irradiation differences of 250 r were found to be decisive. If these same absolute values should hold good, the difference might be distinguishable with the doses from 1,500 r upward which affect the most tender skin, but they might be lost in the margin of natural variation with the higher doses required for any pronounced effect on most peripheral normal tissues and tumors.

Presumably a radiologist with requisite training and facilities may clear up these irregularities and uncertainties and obtain unexceptionable demonstrations of the influence of reduced temperature on radiosensitivity, but the well equipped radiologists have not yet done so. There are simple rules for traumatic shock; it is prevented practically in proportion to the reduction of temperature, and the suspended animation of radical refrigeration makes tissues practically immune to shock. The present work excludes any such crude relation with radiosensitivity. By inference it also precludes classing radiation sickness as a form of shock. At least in the rat, the progression from mild hypothermia to ice temperature does not make a parallel reduction of radiosensitivity. For any practical usefulness, the influence of cold should be both considerable and consistent, and according to this standard the results of refrigeration of peripheral tissues have been negative, except perhaps when combined with local asphyxia by ligation.

Starvation: The increased sensitivity with starvation or cachexia, which was seen in whole body irradiation, is also observable in the peripheral tissues. Four rats, after fasting to the limit of tolerance, were given irradiation of 2,500 to 4,000 r on one hindleg and afterward fed freely. The reactions were perceptibly greater than usual.

The opposite plan, namely starvation after irradiation, was tried in 13 rats with doses graded from 2,500 to 4,000 r. The damage from radiation was certainly not increased and on the average seemed to be slightly diminished.

These effects could be compared in a single animal. A rat weighing 210 gm. was given 3,500 r on the right hindleg (foot included) on May 22, then fed nothing for three days, then given a low diet so that the weight was kept at about 140–150 gm. Vesication was mild, but the ensuing epilation was nearly complete and the ankle partly stiff. On June 26, at 140 gm. weight, the left hindleg was given only 3,000 r, and liberal diet was started immediately. The resulting vesication was severe. By July 16 the foot was swollen and clubbed, and by August 1 it had been lost.

TUMOR TREATMENT

The dosage and results in radiotherapy of rat tumors will be discussed more in detail in an ensuing paper. If low temperature or other factors are to be of any practical aid they must sharpen the specificity; that is, they must either contribute to destruction of the tumor with smaller radiation dosage, or they must increase radioresistance of the normal tissues disproportionately to that of the tumor. A series of experiments with the Crocker rat sarcoma No. 39, implanted in legs or tails, will be only briefly summarized as to results.

Temperature. The temperature studies[12] which formed part of the background of the present work explored the temperature tolerance of rats' tissues, and also confirmed the absence

of any temperature differential between normal and tumor tissues which would enable tumors to be destroyed by either wet heat or cold or any alternations between them. The present series comprised various roentgen-ray doses given with local refrigeration, but not with ligation. Sometimes also the local refrigeration was repeated on a number of days afterward, within the limited strength and tolerance of rats. Necessarily the tumors are retarded in proportion to the time during which they can be kept cold, but there was no practical therapeutic benefit in the sense of either lessened radiosensitivity of the normal tissues or increased vulnerability of the tumors.

Nutrition. A fact long known experimentally and clinically, and confirmed in preliminary experiments in this series, is that fasting or malnutrition does not significantly control tumor growth. The special avidity of the tumor cells enables them to preempt food materials even when the normal tissues are suffering lack. The experimental question was whether tumor cells injured to various degrees by irradiation could still compete successfully with the non-irradiated main mass of the body. Trials were made of various roentgen-ray doses, both alone and combined with refrigeration, followed by starvation and stringent undernutrition for a month or more. The recessions were possibly greater and re-growth was probably slower than in the controls, but since there was no increase of actual cures these alterations did not appear significant.

THEORETICAL DISCUSSION

The literature is characterized by disagreement and confusion concerning the influence of reduced temperature and concerning the Bergonié-Tribondeau or other attempted parallelisms of radiosensitivity with cell activity, growth, metabolism or oxidation. This literature can be traced through the few illustrative references here cited, showing, for example, that for plants, eggs and low animal forms,[14,15,16] according to different writers, cold decreases sensitivity, increases sensitivity or is without influence. Recently Patt and Swift[17] found that the effects of roentgen irradiation of the entire body of frogs could be greatly postponed by cold but the final mortality was not altered (possibly because oxidation in frog tissues did not suffer?). They judged that the mixed findings in the literature "are difficult to reconcile solely on the basis of differences in the test objects and in the criteria of radiation effect employed, and are perhaps indications of the complexity of radiation reactions." Discrepancies can be illustrated in a single mammal, the rat. The well known experiments of Evans,[11] using infant rats chilled to ice temperature, showed protection against roentgen epilation. Mottram,[18] treating rats' tails with radium in water at different temperatures, found no difference between one group at 42–44° C. and another at 30–35° C. Increased sensitivity was found at 0° but no effect at 6° C. Ligation of the tails at the low temperature increased resistance. Mottram explained the variations according to the blood supply, namely the hyperemia at 0° C. and the lack of circulation with a tourniquet.

Methods other than temperature alteration have added support for the protective influence of reduced tissue oxidation. Schwarz[19] was apparently the first to report protection of the human skin against roentgen-ray and radium reactions by local anemia produced by pressure. Others confirmed this resistance with ligations[20] or adrenalin[21] or hemorrhagic anemia[22] or systemic asphyxia[8] in animals. In view of the various influences of chemicals[23] and hormones,[24] undefined humoral agents[25] and the differences in irradiation of the same cell *in vivo* and *in vitro*,[15b] there is ample support for the statement by Cramer and others that the radiosensitivity of a cell is governed not only by its intrinsic character but also by environmental factors.

Intrinsic cell characters may determine reactions to various physical agencies, *e.g.*, heliotropic and heliophobic organisms; also cells (not only from different species but even from the same human body) some of which are killed by slight cold while others survive in liquid hydrogen.[27] The "target" or "threshold" reactions to roentgen irradiations are directly illustrative. It may also be assumed that all poisons have more than

one action, and suppression of oxidation by a poison may not be equivalent to simple deprivation of oxygen. With allowance for these and other possible variables, it may be suggested as a general law that radiosensitivity is not altered by the mere rate of oxidation but is diminished by relative anoxia, *i.e.*, a deficit of oxygen in relation to tissue need. By assuming such a relative anoxia in Evans' chilled rats comparable with the effects of pressure, asphyxia and other oxygen deficiencies, the conflicting reports of the influence of cold under various conditions may be fairly well harmonized.

CLINICAL DISCUSSION

The experiments in this paper illustrate the fact that use of a method during irradiation is entirely different from its use afterward, during the slow development of lesions. While preliminary animal experiments have been regrettably neglected as guides for clinical innovations, it is necessary, on the other hand, to consider the limitations and peculiarities of each species. The rat, in particular, differs widely from man not only in radiation tolerance but also in its reaction to low temperature in either acute or prolonged experiments.[12,13] Numerous clinical questions can be settled only by trials on man. The problems are divided into cooling respectively of normal tissues and tumors, during and after irradiation.

Cooling of Normal Tissues during Irradiation. Evans and Kerr[26] attempted this with either a rubber bag or a roentgen-ray cone containing water circulating at 14–19° C., the cone being also pressed against the skin for further reduction of local circulation and metabolism. The effects were considered somewhat positive, but they were not impressive enough to win general adoption of the method. They at least showed no increase of radiosensitivity by cooling during irradiation, and there seems to be no such claim in clinical literature. As for pressure, if Schwarz's early results were superior to later ones, an explanation may be found in the greater efficiency and greater depth of his pressure. As for cooling, the literature indicates different effects from different degrees of cold, and it was not a difference of species but of method when Evans used trivial cooling of human skin instead of the ice temperature of his rats. Local human tissues can be chilled with equal thoroughness, as in refrigeration anesthesia with or without a tourniquet. After preliminary application of ice or ice bags for one to several hours, Mock has painlessly removed skin grafts, Crossman has found the abdominal tissues insensitive down to the peritoneum, Gratz has broken up adhesions in ankles and knees,[3,27] and Safford has even reduced the intraspinal fluid temperature by 10 degrees. This degree of preparation is necessary for any real test and it will easily last through any radiation treatment. The primary fact is that there are encouraging reports of protection by cold. While operators of supervoltage machines may feel no need of thus guarding superficial tissues, the cooling might conceivably permit of comparable results for the many who have only ordinary voltages. Furthermore, if protection by suitable cold is established as a clinical fact, there may be occasions for utilizing it to protect sensitive structures even with supervoltage, as for example by introducing ice water into the intestine.

Cooling of Normal Tissues after Irradiation. Martin and Caldwell[28] referred to clinical claims of increased or reduced skin reactions with cooling following roentgen treatments (which might be explainable by technical differences). Their findings with a rabbit in a box are indecisive because of species and also because of friction, malnutrition and other possible disadvantages in their method. The discussion of their paper included mention of a patient who received an accidental overdose of roentgen radiation, and with application of ice bags for eighteen hours afterward there resulted nothing more than a mild superficial erythema. To this is now added an authoritative recommendation of prolonged cooling as a routine treatment for

severe roentgen-ray burns.[29] This recommendation is that the advanced stage of roenten-ray burn should be treated like a thermal burn. The unique and even spectacular benefit of properly managed refrigeration for thermal burns is demonstrable experimentally[12] and clinically.[30,31] There is some irony in finding this fact accepted so routinely by radiologists while it is still totally ignored by the great mass of civil and military surgeons who treat thermal burns. On the other evidence mentioned, it seems rational to begin the cooling as soon as possible after the irradiation, without waiting for the appearance of lesions. Several weeks of moderate cooling may be required, as with severe thermal burns. While there may be some possible uses in connection with tumor treatment, there is probably greater importance for atomic bombing and various accidental radiation burns. While the usefulness for peripheral tissue damage may be considered as established, the prospects for minimizing visceral injuries by Temple Fay's artificial hibernation appear not great in comparison with the weakening effect of such prolonged systemic hypothermia. The usual small laboratory animals are entirely unfit for such tests, which could only be feasible in some such species as the hog, which resembles man in tolerance of reduced temperature.

Cooling of Tumors during Irradiation. Freezing cold constitutes a special case. Paradoxically, mouse and rat tumors have proved viable after prolonged freezing, such as normal rodent tissues and most human tissues will not withstand, but clinical tumors which are accessible enough to be frozen completely for a very few minutes can be killed selectively in comparison with the normal tissues.[32] The explanation is not the direct action of cold but the secondary inflammatory reaction, comparable with the effect of heat. Otherwise, it is necessary to distinguish between such hypothermia as the entire body can endure and the ice temperature which peripheral parts can tolerate. Thus, the obtainable effects for external and internal tumors may be different. Assuming the right degree of cold, perhaps with accompanying relative anoxia, it is possible to correlate several fundamental researches as follows. Reduced temperature alone does not alter either respiration or glycolysis of either normal (kidney) or tumor cells in vitro (Goldfeder[33]). Radiation selectively reduces cell oxidation while leaving glycolysis practically unaffected (Crabtree and Cramer[15b]). At low temperatures (0–10° C.) irradiation causes selective lowering of glycolysis while respiration remains unaffected. "It is possible to effect a clear-cut elimination of tumor glycolysis while leaving respiration intact" (Crabtree[15,34]). Together with Warburg's original demonstration of the prominence of glycolysis in tumor metablism, these experiments in vitro suggest a possible selective increase of radiosensitivity of tumors at suitable low temperature.

Cooling of Tumors after Irradiation. The selective increase of radiosensitivity of tumors in comparison with normal tissues is the final criterion of benefit of reduced temperature, in addition to the previously mentioned protection of superficial tissues. Such a biological differentiation would be as important with supervoltage as with ordinary voltage. After-treatment with the necessary degree and duration of chilling is impossible in the rat, because of deficient constitutional strength and tissue reactions of the species. For clinical evidence, certain positive data of Temple Fay have been overlooked amid the rejection of his general proposals. The establishment of a "critical" lethal temperature[35] for cancer cells in vitro is supported by the selective sloughing in vivo, illustrated by the local cure of two breast cancers when systemic hypothermia was reinforced by local refrigeration.[36] Cures in a broader sense were never claimed by Fay, the reasons for failure being that the body cannot endure a low enough systemic temperature to kill cancer, and local refrigeration cannot penetrate sufficiently to overcome the remarka-

bly efficient insulating action of the tissues. Thus Jones and his co-workers[37] confirmed the selective sloughing of cancer as compared with normal tissue, but the penetration was only 6 mm. The chorus of attacks on the Fay method has included not a single suggestion for improvement. The combination of irradiation with cold injury possibly offers such an improvement. The prospects may be best in peripheral regions which can tolerate more drastic refrigeration, but the generally admitted temporary reduction or retardation of tumors with simple "hibernation" may encourage clinical trials with irradiation, which should at least be harmless.

The entire evidence, including protection against whole body irradiation, protection of peripheral tissues under some conditions by cooling during or after irradiation, and the theoretical possibilities regarding tumors, warrants further investigation which must be chiefly clinical and must cover different degrees and durations of temperature reduction.

SUMMARY AND CONCLUSIONS

1. The sensitivity of rats to whole body irradiation was reduced by hypothermia and asphyxia, and increased by starvation and fever. It is noted that hypothermia and starvation both reduce metabolism but they act in an opposite manner on radiosensitivity.

2. Irradiation of legs and tails at near freezing temperature gave variable results, which in general were negative but which at least never indicated increased radiosensitivity. These results may perhaps be clarified with more precise control of conditions. Reduction of radiosensitivity only became consistent when the refrigerated tails were also ligated.

3. The failure to find any broad uniform law of parallelism of radiosensitivity with normal or reduced metabolism, or with normal or moderately or severely reduced temperature, is in accord with similar discrepancies in the literature. Subject to possible exceptions for intrinsic cell characters, a theory of reduction of radiosensitivity not by mere reduction of oxidation but by relative deficit of oxygenation in proportion to tissue need is suggested as coming nearest to harmonizing the divergent findings in a general law.

4. The curability of rat sarcoma is not appreciably promoted by temperature reduction during or after irradiation. The difference of species prevents drawing this conclusion for man. On the contrary, theoretical and clinical considerations encourage further clinical research on cooling during or after irradiation, for protection of normal tissues or possible selective increase of radiosensitivity of tumors.

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DISTRIBUTION AND PATHOLOGY RESULTING FROM THE INTRACEREBRAL AND INTRAVENTRICULAR INJECTION OF RADIOACTIVE GOLD AND SILVER COATED RADIOGOLD COLLOIDS*†

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RELATIVELY little attention has been directed toward the use of radioactive isotopes in the treatment of diseases of the central nervous system. It would seem entirely reasonable that these useful agents could find highly advantageous use in the treatment of certain neoplasms which are nonresectable or only partially resectable, especially in the medulloblastomas. Furthermore, it has been felt for many years that roentgen irradiation can cause the diminution of production of cerebral spinal fluid when such irradiation is directed over the choroid plexus. Accumulation of isotopic material of proper qualities in the latter system might therefore be highly useful in the management of hydrocephalus.

With a view toward producing these two effects and eliminating some of the detrimental effects of roentgen irradiation a suitable radioactive substance for injection both intracerebrally and intraventricularly was sought. Radioactive gold colloids of high specific activity were selected for this purpose.

Hahn and Sheppard[5] first described the use of radioactive colloids in treatment of human disease in 1946. The distribution following intravenous administration was reported the following year.[7] Also in 1947 the use of Au^{198} colloids in the direct infiltration of tumors as well as intracavitary therapy was first described.[4] Recently Davis and Goldstein[1] reported the experimental use of Au^{198} soaked "gelfoam" in cats where the material was introduced surgically into the brain. They found good localization of the radiation effect and no influence on brain tissue of the nonradioactive material in control cats.

The Au^{198} isotope with a half-life of 2.7 days is almost ideally suited for therapy since over 90 per cent of the radiation effect is dissipated in the first ten days, thus allowing a relatively early appraisal of the effects of treatment. Its mixed beta and gamma spectra are quite well fitted to the needs mentioned above since the short half path of the beta particle in tissues (0.4 mm.) does not permit an inordinate amount of irradiation of surrounding normal tissues and structures. On the other hand, the relatively soft gamma component, although contributing little to the irradiation process locally when the isotope is not used in massive quantities, nevertheless allows the measurement and distribution of the therapeutic material externally by the proper equipment. The gold colloid, being metallic, is physiologically inert and does not set up tissue reactions except insofar as these are produced by the irradiation. The highly dispersed sol allows the use of many trilllions of inert point sources of radiation with the inverse square law operating in favor of the therapist rather than against him as in the use of roentgen radiation.[2]

The cross section to thermal neutrons in gold is exceedingly high (100 barns) thus allowing the economic production of isotopic products of high specific activity. These reactions, as currently being carried out at Oak Ridge, yield a product having about 3 curies per gram corresponding to

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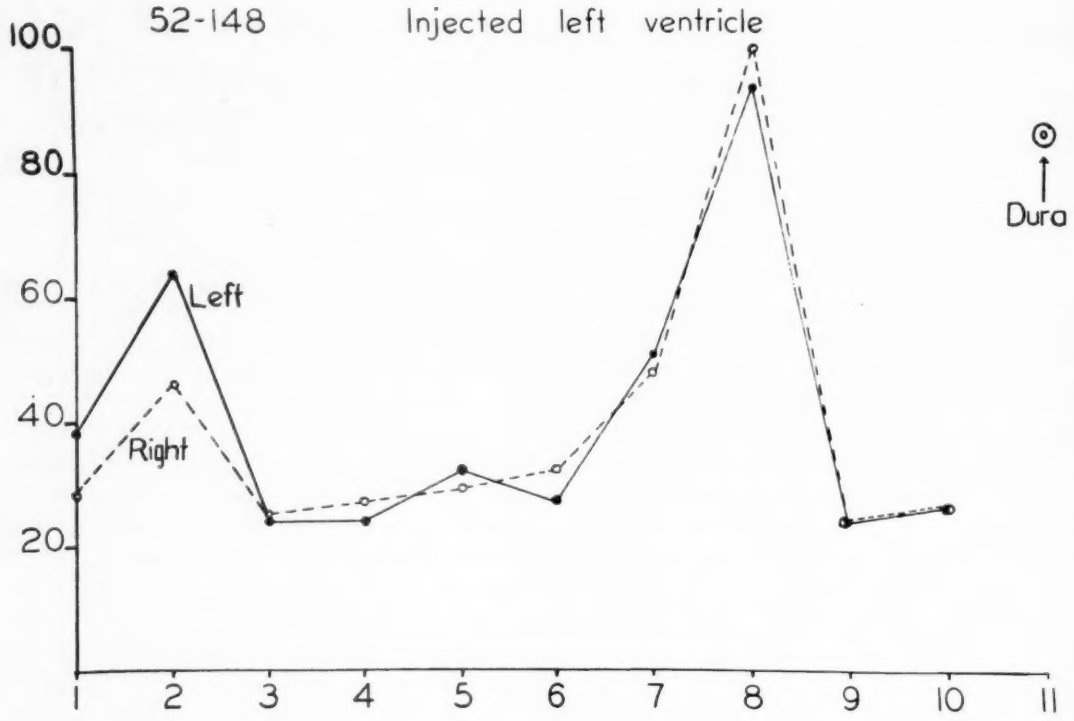

FIG. 1

values of approximately 20 to 40 mc. per ml. of solution as received following some decay in transit. It is well known that nerve tissue is quite radiation insensitive and therefore one is probably not only justified, but advised to go to fairly high levels, in attacking neoplastic conditions in the central nervous system. Assuming tissue density of 1.00 and uniform distribution of colloid in the tissue, one delivers on a millicurie per gram of tissue basis 76,000 equivalent beta roentgens.[2,6] Therefore radioactive gold colloids of high specific activity were administered to two groups of 20 dogs each. In one group of these animals the colloid was injected into one site in the brain substance and in the other group it was injected into a lateral ventricle. The purposes of the entire procedure were four-fold: (1) To ascertain whether the material would be tolerated in these two locations. (2) To determine whether the gold injected into the brain substance would remain where it was injected. (3) To determine whether gold injected into the ventricle would exert its activity on the choroid plexus. (4) To determine whether or not any gross and microscopic alteration would occur in these structures.

METHODS

Healthy adult mongrel dogs maintained on "Purina Dog Chow" ad libitum were used in these studies. A single burr hole was made in the cranium of the dogs and a 20 gauge needle was inserted into the brain substance or the lateral ventricle and varying amounts of radioactive gold[198] were injected. Initially 2 ml. was used, but it was found that this increased the intracranial volume too much. Some of the animals died as a result. As radioactive gold of higher specific activity was obtained* it was finally possible to deliver the same amount of radiation with 0.2 ml. which was generally tolerated much better than the larger amount of fluid. The procedure was also varied by sometimes coating the gold colloid particles with silver† making the particles behave like a silver

* Now obtainable from Abbott Laboratories, Oak Ridge, Tennessee.

† Bombardments carried out at Brookhaven National Laboratory and processing of colloids by Abbott Research Laboratories.

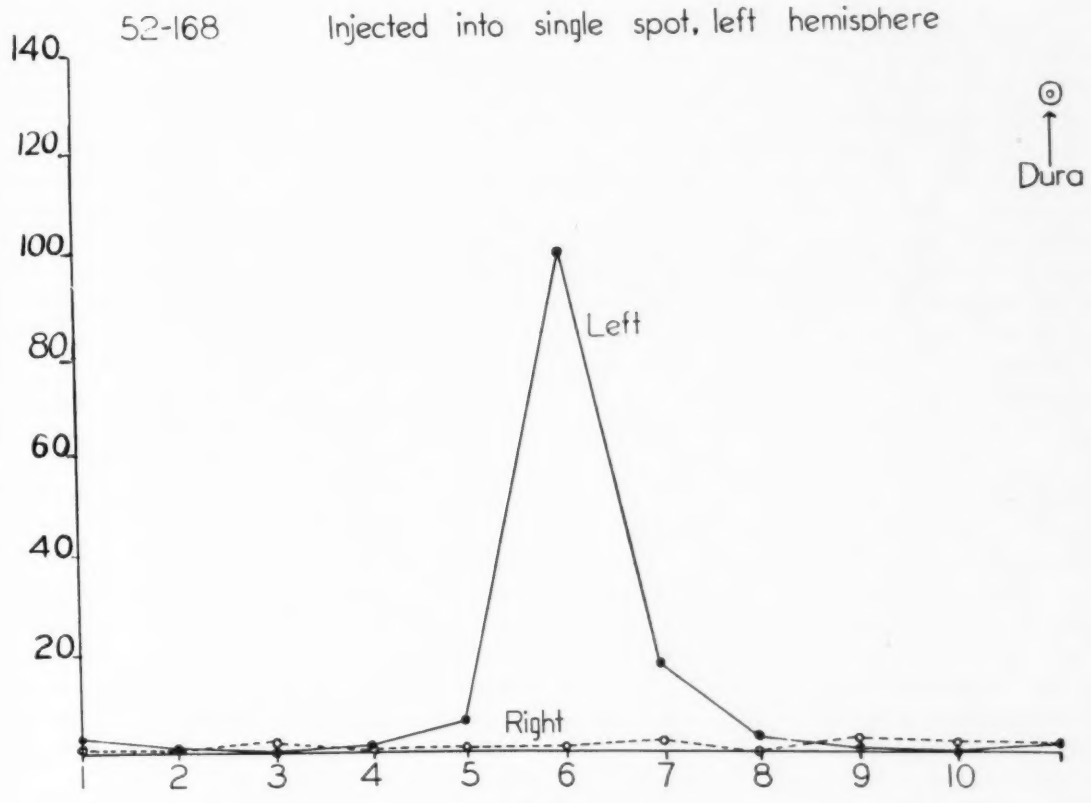

Fig. 2

colloid[3] and at no time did this seem to cause any appreciable difference in the reaction of the dogs to the colloid. Therefore, there will be no further reference or distinction made between these colloids. A total of 58 animals was injected, 28 of these being with the uncoated gold and 30 being with the silver coated variety. Of this number, 6 were not in suitable condition for autopsy making a total of 52 animals studied. Of this group of 52 animals 3 were controls in which decayed gold colloid and decayed silver coated gold colloid were injected into the ventricle.

In view of the small size of the structure, not infrequently in an attempt to inject in one site it was found that it actually represented a ventricular injection, and vice versa. Although it was not intended that the intracerebral and the intraventricular injections be equally divided, there were fifteen purely intracerebral injections, and eighteen intraventricular injections, with the remainder being mixtures of the two, or in other words part intracerebral and part intraventricular.

After different intervals the brain was removed and fixed in 10 per cent formalin for five days. At the end of this time transverse sections of about 0.5 cm. in thickness were made from the fore to the hind part of the brain, these usually numbering twelve in all. Further longitudinal sections resulted in left and right side blocks of tissue which were then photographed in kodachrome. This afforded a visual record of the gross degree of localization of the colloid and the effect of irradiation. Each section was then subjected to radioactivity measurements and these were recorded on a basis of arbitrary counts per minute per gram of fixed tissue. The radioactivity concentration in the dura was measured in most of these animals and found to be quite high in all instances. In 9 dogs the choroid plexus was dissected out for such measurement. Sections for histological study were taken.

DISCUSSION

There are two typical curves resulting from the administration of the colloids by these routes. When injected into the ventricle, one notes (Fig. 1) that the concentra-

tions of radioactivity in relative terms (expressed as per cent of maximum counts per minute per gram of fixed tissue) in any one animal parallel one another on the right and left side. We are not prepared to explain the varying degrees of longitudinal localization, but might say that average values of 18 dogs injected by this route in which radioactivity measurements were made indicate that the parallelism is a constant feature. Also there seems to be some tendency for an increased concentration in the hind part of the brain in such a group. In contrast, when the material is injected into the brain substance at one site, in the ideal case, it is concentrated within a sphere of about 1 cm. in diameter and very sharply localized there as can be seen in Figure 2. The amounts showing up in the contralateral sections are negligible and approximate background readings. Between these two pictures there are numerous variations to be found. In a number of cases in attempting to deliver the material to one site small amounts apparently obtained access to the subarachnoid space on introduction or withdrawal of the needle, and this resulted in an intermediate picture in which the contralateral sections showed moderate amounts of activity but usually paralleling those of the injected side. Here the peak distribution may not be quite so clear cut. However, radioisotope measurement and kodachrome pictures of the brain sections usually allowed one to determine quite accurately where the material was deposited and whether leakage occurred.

To determine the amount of radiation delivered to the choroid plexus as compared to the amount delivered to the brain, two groups of 5 dogs each were injected with the same amount of radioactive material on the same day. One group received the material directly into the brain substance, the other into the lateral ventricle. The animals were all sacrificed five days later, and in the intraventricular group the choroid plexus was dissected out, weighed and radioactivity measurements made. The brains in the directly injected group were dissected as usual and the obviously infiltrated part of the brain measured for radioactivity. As can be seen in Figure 3 the highly active region of one of these particular sections probably represents only about 25 per cent of the particular brain block. When all samples from both groups were calculated on a basis of arbitrary counts per minute per gram of fixed tissue it was found that on the average of the 5 in each group there was a concentration by a factor of about 5 times in the choroid plexus.

Allowing for the fact that in the directly infiltrated brains only approximately one-fourth of the material may have been responsible for all of the radioactivity, this would indicate that the concentration in the choroid plexus following intraventricular administration was at least equal to that of the most active highly concentrated areas following injection directly into the brain substance. Thus, for a given dose by the two different routes there would be approximately the same number of roentgens delivered.

In studying the kodachrome pictures, a reproduction of one being shown in Figure 3, one can see quite readily that a discrete lesion is caused which is further indication that the gold injected into one site remains fixed at that site without affecting the brain tissue in surrounding areas.

It would be too space consuming to give in detail the histological findings in all of the animals. Therefore examples of each type of injection are selected.* In an animal in which one site was injected pathological study showed a defect in the brain substance to be chiefly filled by granular, golden-brown pigment which was enmeshed in fibrin and coagulated serum. This area was surrounded by a zone of edematous brain infiltrated by leukocytes and phagocytes. Around this was a zone of hemorrhage, and finally, a zone of beginning gliosis separated the damaged brain from relatively normal cortex. In a section of brain

* We are indebted to Dr. Roger Terry, Department of Pathology, University of Rochester School of Medicine, for the histopathological examination of these tissues.

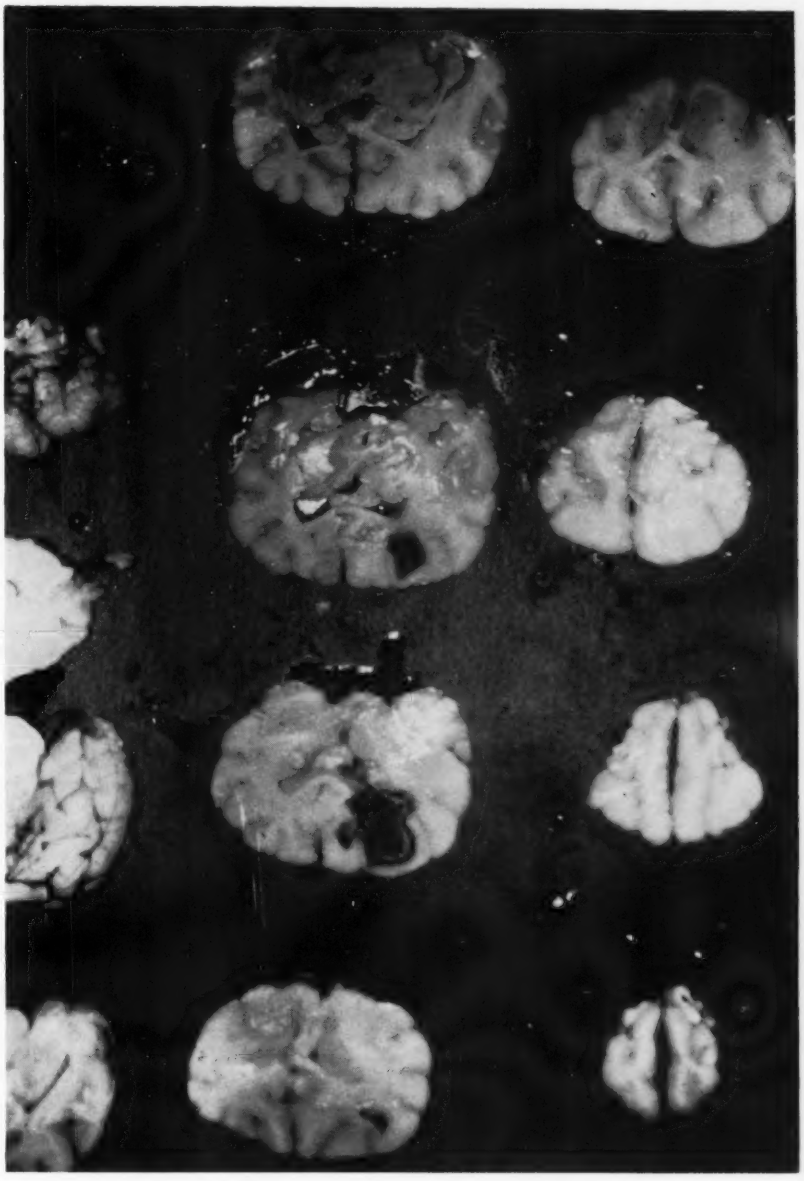

Fig. 3

which had been injected intraventricularly the pathological findings indicated that a small bit of choroid plexus was surrounded by a loose meshwork of fibrin containing scattered leukocytes. Moderate numbers of histiocytes were present in the stroma of the plexus and some of the epithelial cells were quite flat, especially those where bits of exudate clung to the surface. Small foci of hemorrhage were seen in the stroma. In the one animal which had an intraventricular injection and which was allowed to survive for twenty-nine days, the choroid plexus was almost surrounded by partly necrotic fibrin and coagulated serum. The epithelial cells were fairly flat. Numerous histiocytes were present in the stroma. Compressed fibrinoid material and actual areas of fibrosis surrounded and partly compressed small vessels within the choroid plexus. Histopathological findings in the control animals when nonactive colloid

was injected into the brain substance included a suggestion of perivascular edema. A few extravasated leukocytes were present in the leptomeninges but no significant abnormalities were seen. Where the decayed colloid was injected into the ventricle it was found that lining cells of the choroid plexus were low cuboidal. There were numerous chronic inflammatory cells and histiocytes in the stroma of the plexus. Many chronic inflammatory cells were in the thickened leptomeninges. There was perivascular cuffing of many small vessels in the cerebral cortex, with lymphocytes, plasma cells and histiocytes.

It is only fair to mention that not all of the dogs were sacrificed but some of them died at different intervals prior to intended time of sacrifice. It was not felt that this was due to the radioactivity because one of the control animals died in a similar fashion. It was not known whether this was due to technical difficulties resulting in mechanical trauma or whether it was due to infection.

From the above one sees that the purposes of the procedure have been fulfilled. First, the material is tolerated when injected into the substance of the brain and also when injected into the lateral ventricle of the dog. Second, by means of the photographs, the radioactivity per gram of brain, and by means of the microscopic studies of the tissues injected we became quite convinced that the gold remained in the locality in which it was injected. Third, the results of the gold injected into the ventricle were somewhat surprising because even though the amount of radioactivity of choroid plexus would certainly indicate that a large amount of the gold was concentrated in it, the microscopic appearance of the choroid plexus was not appreciably altered. As mentioned before, the ultimate purpose was to try to determine the feasibility of utilizing radioactive isotopes in the treatment of malignant brain tumors and also in the treatment of the communicating type of hydrocephalus. On the basis of our results, it would seem that the use of these isotopes in the treatment of malignant neoplasms of the brain is entirely feasible, in that the material is well tolerated and remains at the point of injection. In spite of the lack of change of the microscopic appearance of the choroid plexus, it is felt that it would also be feasible to utilize the gold colloid in the treatment of hydrocephalus. It is possible that this would require multiple injections and inasmuch as this was not tried during the course of experimentation, its effect is not yet known. The fact that there is a great deal of evidence to support the claim that irradiation of the choroid plexus does diminish its secretions and the fact that these experiments bore out the contention that the gold did exert its principal effect on the choroid plexus supports such hypothesis. It will of course be necessary to await the opportunity for trial in suitable subjects to further support these contentions.

SUMMARY

Injection of radioactive gold colloids and silver coated radioactive gold colloids into the brain substance resulted in localization of the material roughly in proportion to the volume administered.

When such colloids were injected into the lateral ventricle of the brain there was a diffuse parallel distribution of the colloid in both the right and left side with slight concentrations in some regions in the fore and hind part of the brain. There was a considerable concentration of the material in the choroid plexus but gross and histological examination of this structure did not show anything but minimal changes.

The possibilities of the use of such inert colloids in treatment of malignant brain tumors and hydrocephalus are briefly discussed.

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LARGE DOSES OF I^{131} IN DOGS

RADIATION DOSAGE CORRELATED WITH HISTOLOGIC AND AUTORADIOGRAPHIC CHANGES*

By MARTIN B. LEVENE, M.D.,† GOULD A. ANDREWS, M.D., *and* RALPH M. KNISELEY, M.D.

IN RECENT publications[1,2,4] pathologic changes in human thyroid tissue following large doses of I^{131} have been reported and emphasis has been given to the variability of response. There are also a number of comparable studies in small laboratory animals. Observations in larger animals, in which the thyroid gland more closely approaches the size of that in man, have been limited. Studies were made by Hamilton[8] on 2 dogs in the early days of radioiodine investigation, and by Goldberg and Chaikoff[6] whose histopathological findings were a by-product of observations on myxedema produced by means of radioiodine in dogs.

Since the distribution of ionization produced by I^{131} is dependent on the volume and dimensions of the thyroid and since the dose received by adjacent structures depends upon their size and proximity to the thyroid, pathologic changes must be considered in relation to the size of the animal. The thyroid of the dog, while still much smaller than that of man, is more nearly comparable to it than are the thyroids of the small experimental animals.

MATERIALS AND METHODS

Eight mongrel dogs, weighing from 11.0 to 15.7 kilograms, unselected in age and sex, and without special dietary preparation, were given I^{131}. The dose was calculated at 1.5 millicuries per kilogram, with 10 micrograms of carrier iodine added and administered intravenously. The dogs were housed in individual metabolism cages, where daily twenty-four hour urine collections were made. Venous blood samples were also obtained daily in heparinized syringes. Radioactivity over the thyroid region was measured each day by means of a collimated Geiger tube. The angle of acceptance permitted counts to be received from a circular area approximately 8 cm. in diameter at the counting distance of 25 cm.; comparison with a standard aliquot of the original I^{131} solution was made.

On the 3rd, 4th, 5th, 6th, 9th, 12th, 20th, and 31st days after administration of the I^{131}, one animal was killed by exsanguination under anesthesia. The thyroids, parathyroids, and an adjacent section of trachea were removed from each dog. Immediately after removal each pair of thyroids was assayed against the same standard, using both the collimated Geiger tube and a Lauritsen electroscope. The glands were then weighed, blocks were cut and were fixed in formalin for subsequent histologic and autoradiographic preparation. The remaining portions of the glands were then weighed and digested in 2 per cent NaOH for radioassay. Plasma, urine, and digested thyroid tissue were assayed in Marinelli beakers with a calibrated bismuth cathode type Geiger tube. On each specimen a number of serial histologic sections were obtained. Autoradiographs were made; adjacent sections stained with hematoxylin and eosin were prepared to show finer histologic details than could be seen in the autoradiographs. Sections of the trachea and parathyroid were also prepared for routine histologic study.

RESULTS

Clinical Observations and Measurements of Radioactivity. During the period between injection and sacrifice there was little departure from normal in the clinical behavior of the experimental animals. Dogs No. 6 and 8 experienced considerable diarrhea during the first week but did not appear otherwise ill.

The radioiodine content of the thyroid gland expressed as a percentage of the original dose is shown for each dog during the

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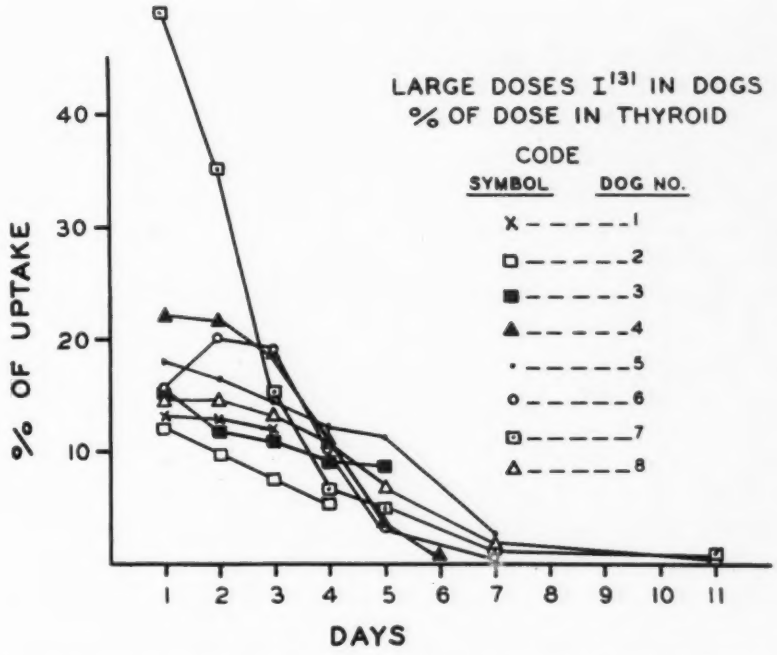

FIG. 1. Per cent of I^{131} in the thyroid of each dog during the period of observation.

period of observation (Fig. 1) together with the daily urinary excretion of I^{131}, also in terms of per cent of dose (Fig. 2). The daily I^{131} plasma level is shown in microcuries per milliliter (Fig. 3). The initial uptake of radioiodine by the thyroid glands varied from 12.9 per cent to 22 per cent with the exception of one dog in which it was 49.5 per cent.

Between the third and fifth days follow-

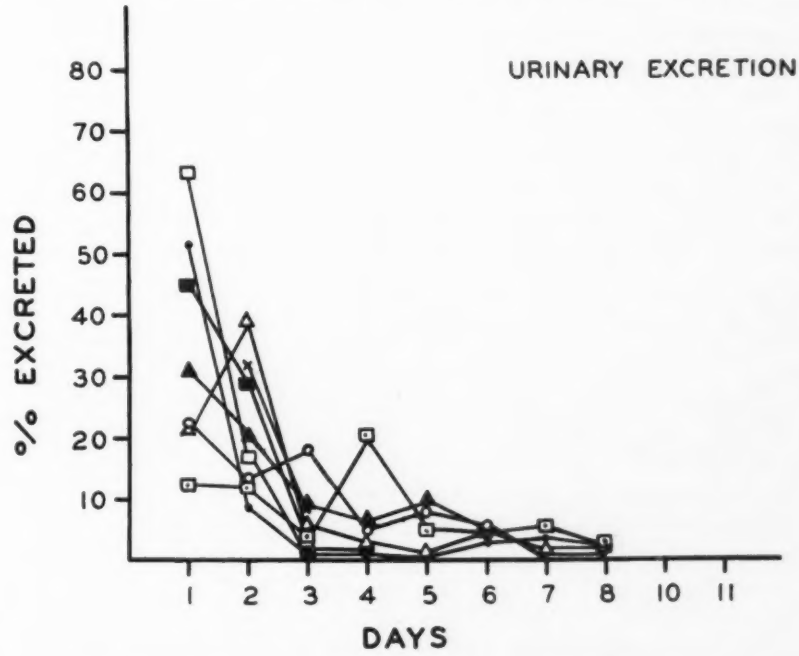

FIG. 2. Per cent of I^{131} excreted in the urine each day.

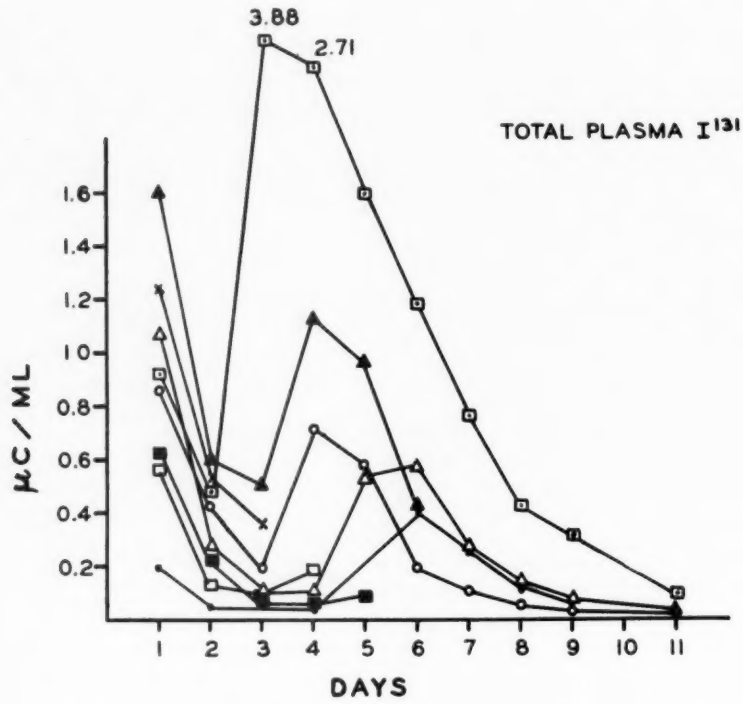

FIG. 3. Daily plasma values of I^{131} in microcuries per milliliter. Note the rise in activity in the three to six day period.

ing the administration of the original dose, a sharp decline in the thyroid I^{131} was noted, followed within the next twenty-four hours by a pronounced secondary rise in urinary I^{131} excretion. The animal whose initial uptake reached 49.5 per cent followed a similar but exaggerated pattern with a more rapid decline in thyroid content and an unusually high rise in the plasma level.

Table 1 summarizes data related to calculated tissue dose and histopathologic changes. The dose delivered to the thyroid gland by I^{131} irradiation has been calculated for a uniform distribution model of the thyroid of each animal using the relationship that an initial concentration of I^{131} of 1 microcurie per gram will yield 12.5 beta equivalent roentgens in twenty-four hours. An additional 10 per cent has been added as the approximate gamma contribution to the dose, although this may be somewhat high since it is based on the figure for a

TABLE I

Dog No.	Weight kg.	Dose mc.	Sacrificed days	Thyroid Necrosis	Final Thyroid Weight gm.	Grams of Thyroid Per Kg. Body Wt.	Calculated Thyroid Tissue Dose rep
1	15.7	24.9	3	0	1.07	0.068	106,000
2	11.0	16.4	4	+	0.66	0.060	106,000
3	12.3	17.8	5	+	1.06	0.086	110,000
4	12.7	20.2	6	+++	0.86	0.067	218,000
5	12.8	21.1	9	+++	1.47	0.114	133,000
6	13.9	21.6	12	++++	0.36	0.026	509,000
7	13.9	21.8	20	++++	0.89	0.064	343,000
8	14.4	22.8	31	++++	0.46	0.032	380,000

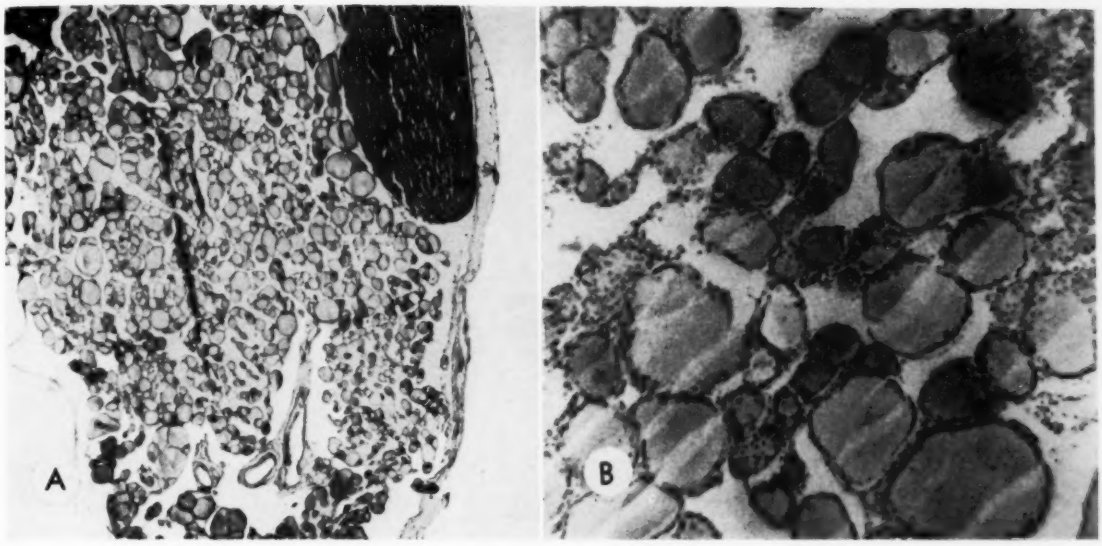

Fig. 4 (*A*) At three days (Dog No. 1) the thyroid is intact microscopically. Note normal parathyroid. Hematoxylin and eosin, ×15. (*B*) Autoradiograph at three days (Dog No. 1) showing patchy uptake of I^{131}, ×100.

gland of human size. The figures at best, however, are approximations of the total energy absorbed by the thyroid since the calculations are dependent on the weight of the gland obtained at the time of autopsy. Examination of column 5 in Table I, which gives the thyroid weight per kilogram of body weight, suggests that indeed some of the weights are decidedly low, probably as a result of the radiation effects. As a result, the calculated radiation dose for these models of glands is probably somewhat higher than the true figures.

Table II

Per cent of original dose in total thyroid tissue at time of sacrifice

Dog No.	Sacrificed days	Whole Gland Radioactivity Measurement			Calculated Value Wet Assay of Tissue Aliquot
		Geiger-Müller tube		Electroscope in vitro	
		In vivo	In vitro		
1	3	12.1	13.5	—	10.1
2	4	5.3	7.2	5.8	5.0
3	5	8.7	9.1	9.4	9.9
4	6	1.3	0.45	0.61	0.55
5	9	0.7	0.6	0.8	0.5
6	12	—	—	0.07	0.03
7	20	—	—	—	—
8	31	—	—	—	—

Since the figures for daily I^{131} content were also used to calculate the dose, an attempt was made to check the accuracy of estimating the per cent content by means of external counting. Table II compares the results obtained by external counting of the thyroid glands just prior to and after sacrifice with measurements made by the Lauritsen electroscope and radioassay of digested tissue. It appears that external counting was a satisfactory method of determining the I^{131} content of the thyroid when fairly large amounts were present.

Histopathological and Autoradiographic Observations. The histopathologic features following large doses of I^{131} can be divided into three stages. A latent period of approximately three days during which no changes are apparent is followed by the period of beginning reaction and breakdown from the fourth to the sixth day, without frank necrosis. From the sixth day on, necrosis is diffuse and severe.

In Dog No. 1 (three days) follicles were intact and lined with cuboidal epithelium (Fig. 4*A*). There were occasional pyknotic

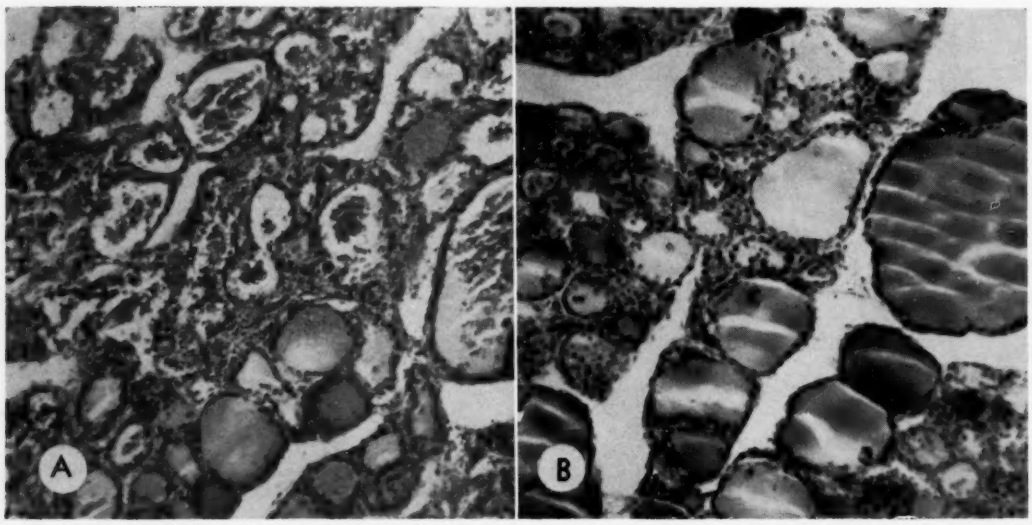

FIG. 5. (*A*) At four days (Dog No. 2) there is general preservation of architecture but beginning breakdown with hemorrhage and neutrophilic infiltration. Hematoxylin and eosin, ×100. (*B*) In Dog No. 3 (five days) changes less pronounced but in general similar to (*A*). Hematoxylin and eosin, ×100.

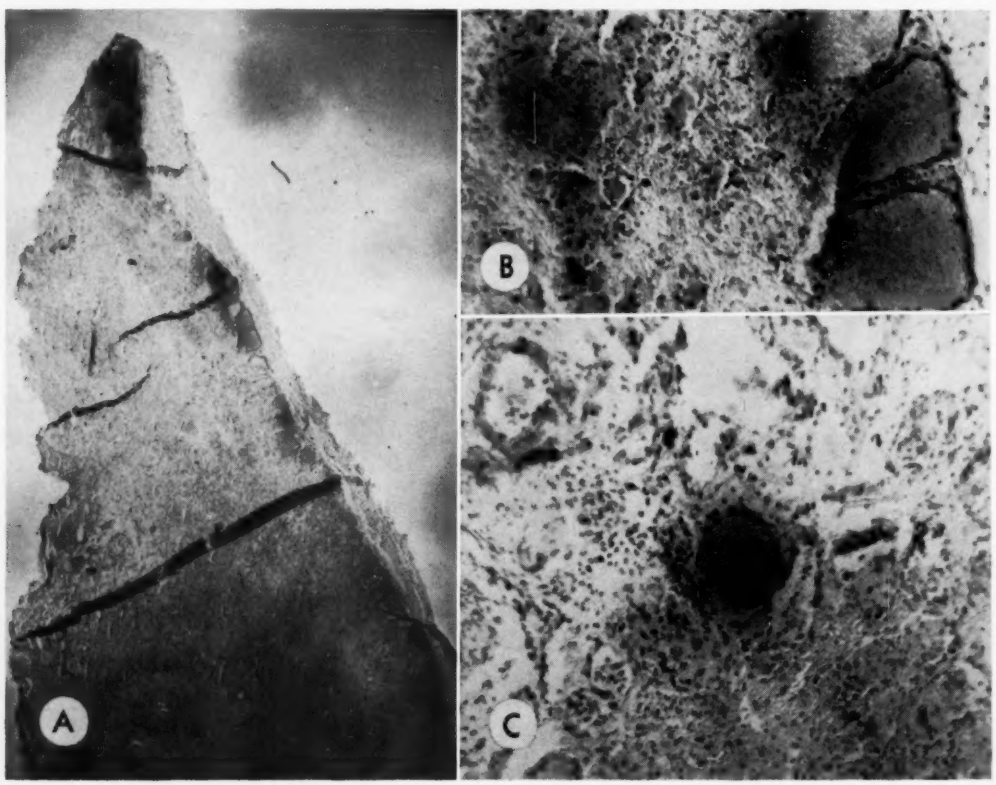

FIG. 6. (*A*) Autoradiograph of Dog No. 4 (six days). There is widespread histologic necrosis with only a patchy rim of preserved follicles. These follicles show focal concentrations of I^{131}, ×15. (*B*) High power view of capsular region of (*A*). Note viable appearing follicles and emulsion darkening localized to the follicles, ×100. (*C*) A solitary centrally located follicle, not shown in (*A*), apparently viable, though surrounded by necrotic tissue, ×100.

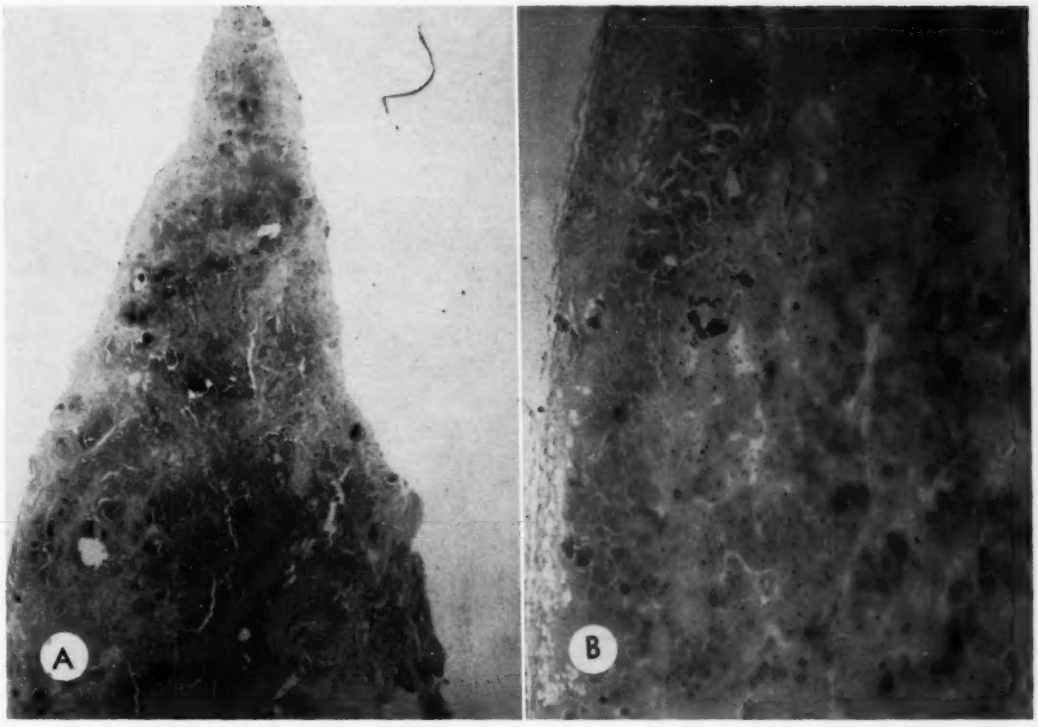

Fig. 7. (*A*) At twelve days (Dog No. 6) a diffuse hemorrhagic necrosis without any remaining viable follicles at the rim. Hematoxylin and eosin, ×20. (*B*) Autoradiograph of Dog No. 7 sacrificed at twenty days. There is a bloodless infarcted tissue with hemorrhagic necrosis near the capsule. Focal zones of radioactivity are scattered through the nonhemorrhagic zone as if localized to follicles, ×20.

nuclei in and between follicles which may represent degenerating inflammatory cells. This change was minimal. The autoradiograph showed radioactivity unevenly localized in follicles (Fig. 4*B*). In Dog No. 2 (four days) the thyroid gland showed areas of neutrophilic infiltration in the capsule. Many follicles appeared normal but were small with pale staining colloid. Hemorrhage into the interstitial tissue and into scattered follicles was observed (Fig. 5*A*). The autoradiograph showed a spotty focal deposition in the follicles. In Dog No. 3 (five days) changes were similar to those in the four day dog, although not so pronounced (Fig. 5*B*). All of the thyroid tissue from these 3 dogs was grossly normal in appearance.

A striking alteration was noted grossly in Dog No. 4 (six days). The gland was reddish black and hemorrhagic. On microscopic examination there was a widespread hemorrhagic necrosis with follicle outlines still recognizable. In most areas the epithelial cells were destroyed. The granular colloid which remained was infiltrated also with numerous leukocytes, including neutrophils, monocytes, and lymphocytes. In the zone of severe destruction, fibrinoid thickening of the intimal region was seen in some small vessels. Of particular interest were groups of preserved follicles forming a discontinuous rim immediately beneath the capsule (Fig. 6). Autoradiograph showed focal concentrations of I^{131} greatest in these preserved follicles. One exception was a solitary surviving follicle seen in one autoradiograph. The follicle was in the center of the gland, surrounded by necrotic tissue (Fig. 6*C*). Dog No. 5 (nine days) showed similar gross and microscopic features, although the destructive process did not appear to be quite so severe in this animal. The dark hemorrhagic and necrotic central

FIG. 8. High power view of necrosis in Dog No. 6. Note hemorrhage, complete destruction of follicles, and degeneration of vessel wall with thrombotic material in lumen. Hematoxylin and eosin, ×100.

area observed grossly in Dog No. 5 appeared to be surrounded by a thin shell less than 1 mm. in width of mottled pink and red tissue. Microscopically the patchy, subcapsular zones of viable appearing tissue seen in the six and nine day animals never extended more than the diameter of one follicle into the substance of the gland. The maximal diameter of this subcapsular zone was about 200 microns.

In the twelve day animal (Dog No. 6) the lobes were wrinkled, soft, gray-black in color throughout. On microscopic examination a diffuse severe hemorrhagic necrosis of the gland was observed without any remaining colloid or viable follicular epithelium (Fig. 7*A*). There were relatively few inflammatory cells; phagocytosed blood pigment was scattered throughout the tissue. This widespread necrosis also involved the vessels, and thrombi were seen within portions of some of the lumens (Fig. 8). The adjacent adipose tissue showed focal collections of monocytes and neutrophils. The autoradiograph showed several focal areas of radioactivity not correlated with any recognizable follicle. These focal zones were seen both with the central portion of infarcted gland as well as peripherally just under the capsule.

Dog No. 7 (twenty days) was of special interest because of the unusually high amount of the I^{131} initially concentrated in the thyroid. Grossly the lobes were firm, reddish black and hemorrhagic throughout. On microscopic examination the gland was necrotic with a bloodless infarcted framework in the central portion and hemorrhagic necrosis of the periphery. The vessel walls showed fibrinoid swelling; phagocytes with blood pigment were present in the capsule. In the autoradiograph there was focal deposition of I^{131} scattered throughout the central nonhemorrhagic zone as if the radioactivity was localized to follicles, even though only the ghost-like histologic outlines remained (Fig. 7*B*).

Similarly, in Dog No. 8 (thirty-one days) a complete widespread hemorrhagic necrosis was present with focal zones of hemorrhages apparently in follicle sites. There was very little cellular reaction present in the gland. Foci of hemosiderin-laden phagocytes were found in the capsule. There were thrombi of vessels in and near the gland. A few widely scattered follicle-like spaces with a blue granular colloid persisted. The autoradiograph showed several widely scattered foci of radioactivity, but these foci were not at the sites of the recognizable follicular remnants.

Sections of the adjacent tracheal mucosa showed no significant alterations. The parathyroids showed no necrosis and no uptake of I^{131} by autoradiographic study. They were small and shrunken, and rather compact in appearance from the sixth day. In one instance there was some hemorrhage in the soft tissue around the parathyroid gland.

DISCUSSION

The present study presents information limited to the early effects of large doses of radioiodine. It appears that the ionization was sufficient in all these cases to completely destroy the thyroid tissue and many areas undoubtedly received doses far ex-

ceeding the level necessary to produce necrosis. With smaller doses incapable of producing complete destruction of the gland, the cumulative total ionization during the first few days might lead to gradually developing histopathologic changes dependent upon the increment of dosage. In the present series, however, it is believed that the important differences at the various intervals after administration are related chiefly to the time required for development of morphologic evidence of inflammation and necrosis, rather than to the higher dosages in the animals sacrificed at later times. We believe that if all the radioactivity could have been removed from the glands after three days when there was no demonstrable histologic effect, the sequence of later changes would have been essentially the same as those seen. Published reports suggest that this sequence of events occurs more rapidly in rats and mice than in dogs, and our own experience indicates that it occurs even more slowly in human beings. These effects are not believed to be independent of dosage, but it is emphasized that with large doses in the range of those given to human patients for total destruction of the thyroid, the effects follow a distinct sequential pattern with an initial latent period. For these reasons the differences in the doses listed in Table 1 are probably not of great significance in explaining the differences in degree of change seen. Furthermore, the dosages calculated in Table 1 are based upon the ultimate weights of the thyroid glands at the time of sacrifice and since considerable shrinkage had undoubtedly occurred as a result of radiation, this factor would introduce an error in the direction of erroneously high calculated tissue doses.

A clear sequence of events occurred in these animals. On the third day there were no demonstrable histologic changes, but by the fourth day beginning damage was evident and this progressed rapidly to an extensive necrosis. During this period of fulminating change, from the fourth to the sixth day, there was a fall in the I^{131} content of the glands and a rise in the plasma radioactivity. This fall and rise is believed to represent liberation of I^{131} from the sites of damage in the thyroid. The fact that most of this iodine was probably not free iodine was suggested by the relatively small increase in the urinary excretion.

The autoradiographs contributed to the understanding of these changes. In the three day animal the expected uneven follicular distribution of the isotope was seen, with somewhat greater concentration in large follicles. By the sixth day a striking change had occurred. Much of the isotope had left the main part of the gland, with residual focal areas of high activity localized in the intact follicles in the subcapsular region. This phenomenon appears to confirm the fact that release of iodine is closely correlated with the process of necrosis. A similar situation was seen on the ninth day. By the twelfth day there was no remaining rim of preserved follicles. In the 3 animals sacrificed at 12, 20, and 31 days there were no longer any areas of preserved follicles histologically, but autoradiographs made with sufficient exposure still showed some focal areas of radioactivity suggesting a follicular pattern. In the thyroid of the twenty day dog (No. 7) which had the high initial uptake and the rapid release, there was actually less residual I^{131} by the autoradiograph at the edge than there was in the center. A hypothetical explanation is that in the central area, necrosis was so rapid and was associated with so much vascular damage that there was less efficient removal of I^{131} than there was at the edge where the necrosis occurred later and more slowly.

In multiple reports by various authors,[3,5,7] it has been noted that the early radiation effects appear throughout the gland except at the periphery where the follicles suffer less damage and tend to regenerate even though the remainder of the thyroid is completely replaced by fibrous tissue. In the present study an uneven, discontinuous "protected zone" was prominent in the six and nine day animals, but in

the later animals, where a greater dose had been delivered and a greater period of time elapsed for the process of necrosis to develop, no such rim was seen.

A possible reason for lack of necrosis in the peripheral follicles would be a lower average concentration of the isotope in this zone. Although we have made no quantitative study of this, the autoradiographs fail to show any obvious evidence of such a distribution pattern. Another possible mechanism would be a decreased radiosensitivity of the peripheral zone associated with lowered oxygen tension or some other factor related to the vascularity and metabolic activity in this area. Again, we have no evidence for any such difference between the central and subcapsular parts of the gland.

Oddie[9] has calculated the beta-ray dose to be expected in a hypothetical thyroid consisting of a sphere of tissue containing I^{131} concentrated in a large number of small, equal spherical volumes which are equally spaced in a rectangular lattice arrangement within the large sphere. He reports that the dose rate to different parts of the tissue may vary by a factor of over 100 if there is spotty distribution. On the other hand, with uniform distribution of the isotope throughout the gland, there would be only a two fold difference between the beta-ray dose rate at the center of the gland and that at the surface. Since I^{131} is known to be distributed unevenly in the thyroid gland, one might expect, on the basis of these calculations, to find islands of surviving tissue scattered throughout a gland that has been subjected to sufficient radiation to necrose part but not all of the tissue. Because of this uneven distribution of the isotope, a group of follicles in the central portion of a gland could conceivably receive a radiation dose much less than a similar group at the periphery and the peripheral follicles should not necessarily be expected to be preferentially spared. However, on the average, the subcapsular zone should receive a relatively low beta-ray dose because the cells of the outermost follicles are not subjected to radiation from all directions. Since the average energy of the iodine 131 beta particles is slightly over 200 kev. their average range in tissue will be somewhat less than 0.5 mm. and this zone is a narrow one.

The ionization resulting from the gamma-ray emission of the isotope is believed also to have an irregular distribution resulting from the uneven deposition of the isotope, but the range of variation is presumably smaller than for that due to the beta-ray emission. On the basis of a model, containing an even concentration of the isotope, the ionization due to the gamma rays would fall gradually from the center to the edge of the gland, without any sudden decrease in the subcapsular zone.

The factors influencing the distribution of histopathologic necrosis in the thyroid gland are obviously complex and poorly understood. It is the opinion of the authors that the most important single explanation for the subcapsular groups of preserved follicles is the lack of crossfire to these follicles from beta particles.

SUMMARY

(1) Normal dogs were given 1.5 millicuries per kilogram of I^{131}. A distinct time pattern of histopathologic changes was found, with morphologic evidence of inflammation and necrosis developing after the third day. Destruction of the gland was correlated with release of I^{131} from the thyroid into the blood stream.

(2) A patchy rim of preserved follicles was seen in the animals sacrificed on the sixth and ninth day intervals, and these follicles were shown by autoradiographic studies to have retained the radioisotope selectively. At later intervals necrosis was complete, and autoradiographs showed focal zones of radioactivity.

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A CdS RADIATION PROBE OF HIGH RESOLUTION*

By C. H. BACHMAN, O. J. GELORMINI,† *and* H. W. DAVIS

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THE various types of ionization chambers customarily used in measuring roentgen radiation all require that the sensing element be immersed in radiation. This requirement is not difficult to meet in the case of the usual roentgen-ray beam. However, it made impossible the use of such measuring equipment in connection with the convergent beam tube, elsewhere described, [1,2] where the radiation is in the form of a convergent hollow conical sheath, the sheath being a millimeter or less in thickness.

To obtain depth dose information for this tube it seemed necessary to use the time-consuming technique of photographic densitometry and such a program was started. Before its completion our attention was called to the possibilities of the photosensitive CdS crystal. Such crystals in sizes less than a millimeter exhibit marked changes in conductivity when exposed to roentgen radiation and contrary to many other photoconductive materials have very low dark current. The characteristics of such crystals, their peculiar suitability to roentgen-ray work and some applications have been described in the literature.[3,4,5,6,7,8,10,11]

Using crystals kindly furnished us by the General Electric X-ray Department we developed a probe sufficiently small to allow detailed measurement of the intensity distribution of the convergent beam tube.

The crystals with which we started were small flakes and irregularly shaped fragments with no dimension larger than 2 or 3 mm. It was necessary to mount one of these tiny crystals in a suitable holder in such a way that the unit was light tight and protected from the atmosphere. Electrodes had to be provided on opposite faces and the whole mount had to be highly resistive electrically to prevent leakage currents that might mask the true crystal conduction. It was also desired that the completed probe be of a shape such that it could easily be inserted in a masonite phantom.

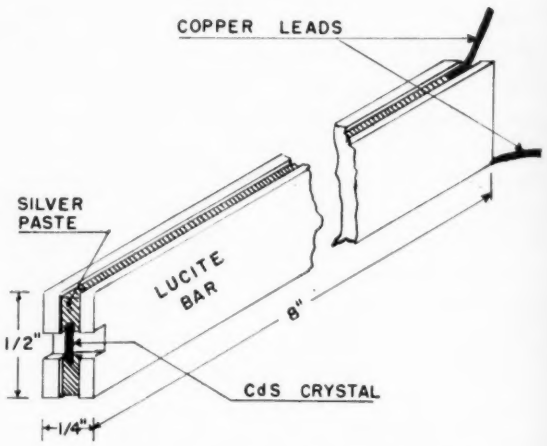

FIG. 1. Construction details of CdS probe.

The probe finally developed is shown in Figure 1. The crystal was placed in a slot in the end of a lucite rod of rectangular cross section and of thickness equal to that of the masonite sheets. Using Du Pont air drying silver paste No. 4817, electrodes were painted on opposing crystal faces and then conducting lines were continued down the edges of the lucite rod in narrow grooves to metal connectors at the end of the rod. These grooves were then filled with polystryrene cement up to and around the crystal thus imbedding the crystal with its painted electrodes.

The entire probe was given a coat of flat black paint to prevent irradiation by visible light and the handle end was further protected with plastic electrical insulating tape. The literature[9] mentions that heating CdS in oxygen increases the photosensitivity and a process of heat treating was

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worked out which gave us sensitivity increases of 2 and 3 fold.

In use the probe is connected in series with a small radio type B-battery and an RCA ultrasensitive d.c. microammeter (Fig. 2), which can read directly currents of about 10^{-9} amperes. Irradiation of the crystal by roentgen rays increases its conductivity and the microammeter will indicate current which is a function of the intensity of radiation and of the voltage in the circuit. (We used up to 180 volts in our work.)

Although the literature on CdS describes the general characteristics, it seemed desirable to determine for ourselves the type of response we might expect under the conditions of our investigation. Primarily we were interested in response to intensity variations for tube voltages of 20–60 kv., that being the operating range of the convergent beam equipment. The effect of different crystal voltages was of interest and we were also interested in the resolving power of the detector—the degree with which it would indicate intensity variations in the distribution pattern of the beam.

It is reported[9] that the sensitive portion of a crystal is a layer immediately next to the negative electrode. This being true one is immediately provided with one extremely small dimension for the detecting element and the crystal can be of a conveniently greater length. (A typical crystal in our work was about 1 × 0.4 mm. in cross section and 2 to 3 mm. long.) It seemed desirable that we determine the resolution capabilities experimentally.

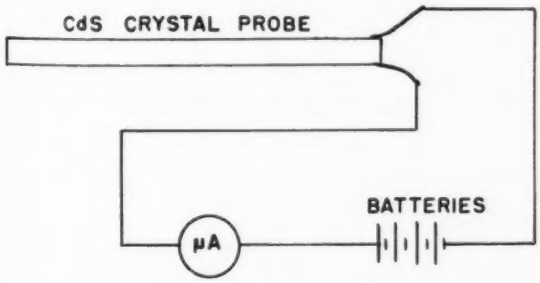

Fig. 2. Simple circuit employed in the use use of the probe.

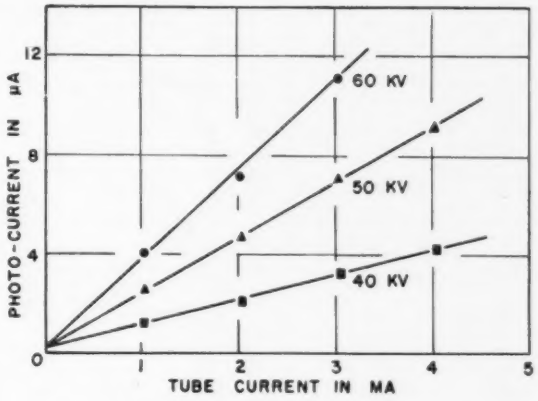

Fig. 3. Probe current vs. roentgen tube current for several tube voltages.

The response of the CdS to variations in radiation intensity may be seen by plotting crystal conduction current against electron current in the roentgen tube (intensity of radiation is assumed to vary directly with electron current.) Curves of this type are shown in Figure 3 for several tube voltages. For our relatively low radiation levels linearity of response was indicated.

The effect of varying the voltage in the crystal circuit is shown for two probes in Figure 4. It can be seen that linearity is assured by operating at less than 200 volts.

In the experiment to examine the capabilities of the probes for resolution of beam detail, a series of slits were arranged side by side in the beam of a Machlett tube (type CYR-B). These slits varied in width and in spacing from each other (Fig. 5). Provision was made to pull the probe slowly past these slits and the conduction current was plotted against probe position (Fig. 6).

The probe mechanism was then removed and a film placed against the slits and exposed. A densitometer trace was made of this film (Fig. 7). It will be seen that with the exception of a slight rounding of corners resulting as the crystal moved past on edge, the resolution is good. The narrow slit (distance 16) is only about 1 mm. in width and is well resolved. Such a probe seemed adequate for investigating our convergent sheath.

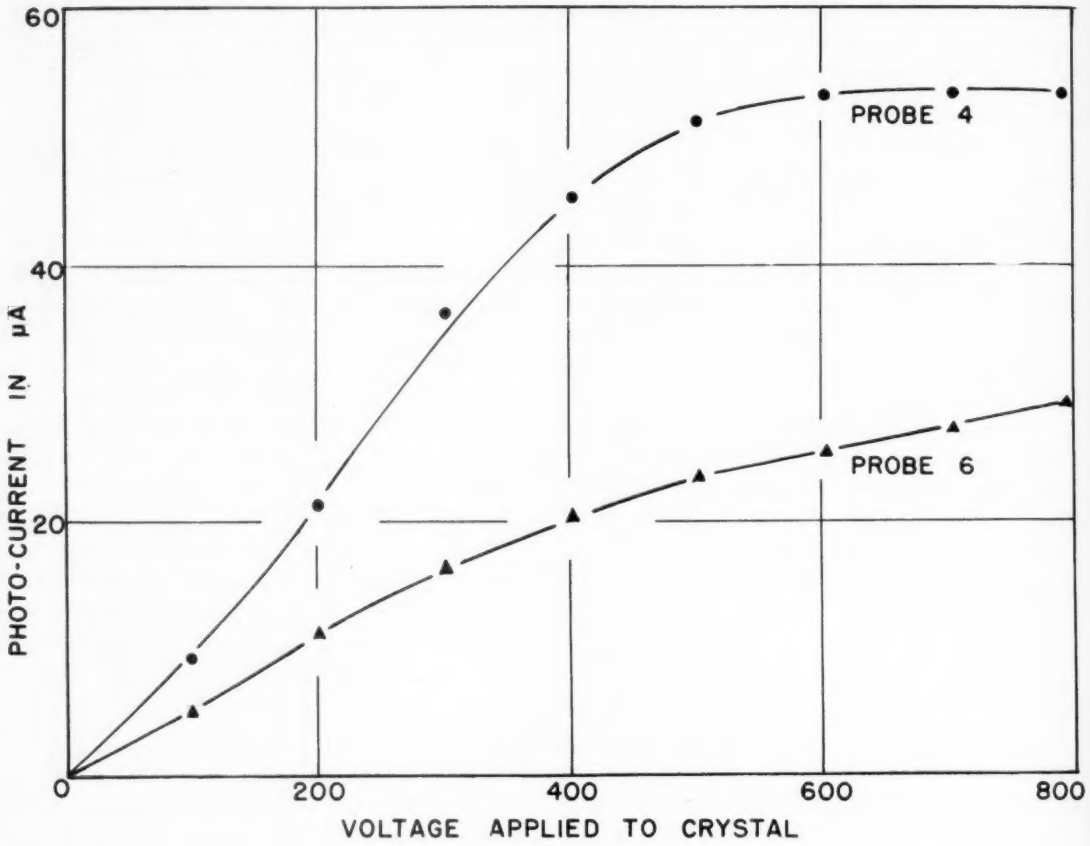

FIG. 4. Probe current vs. probe voltage.

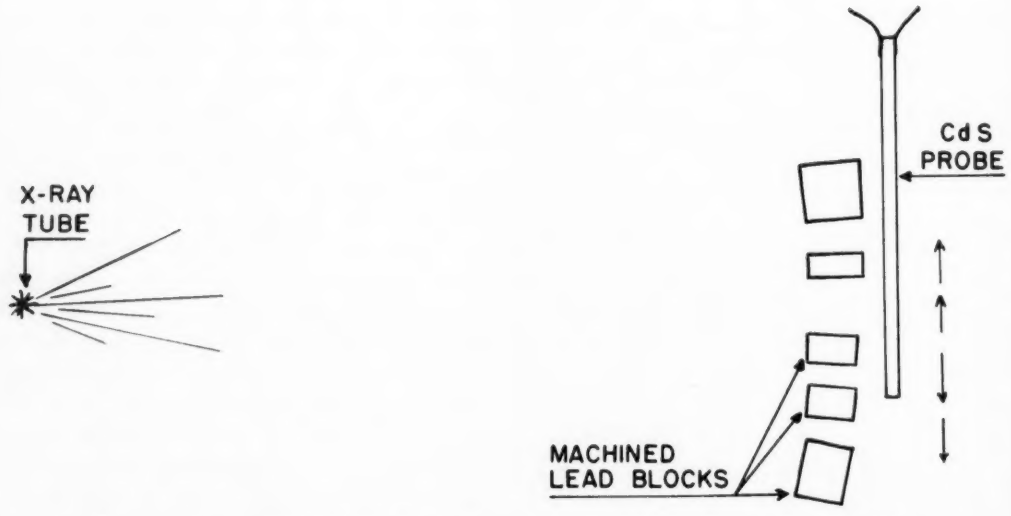

FIG. 5. Arrangement of lead slits used to determine the resolution characteristics of the probe.

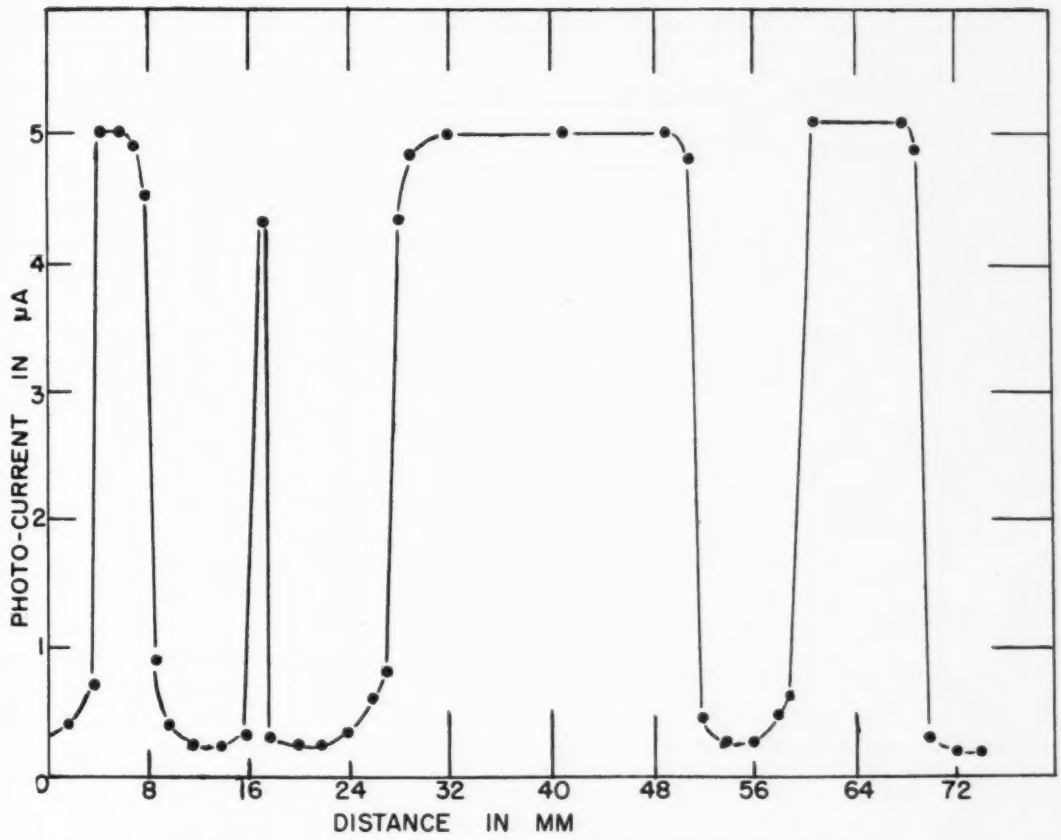

FIG. 6. Radiation pattern back of slit apparatus showing resolution capabilities of the probe.

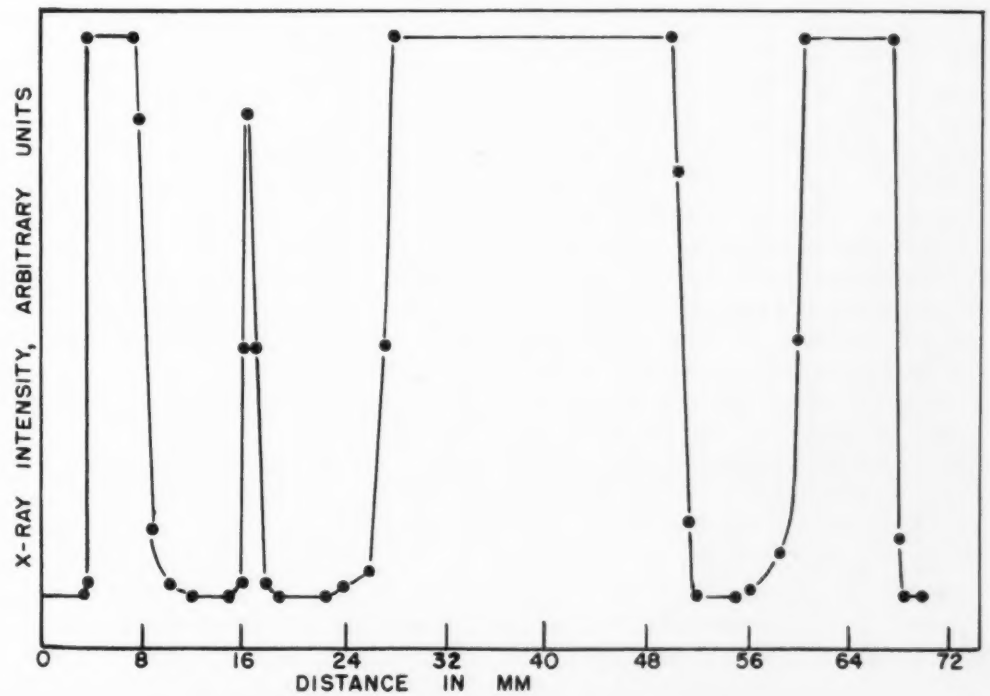

FIG. 7. Densitometer trace of film exposed through the slit apparatus.

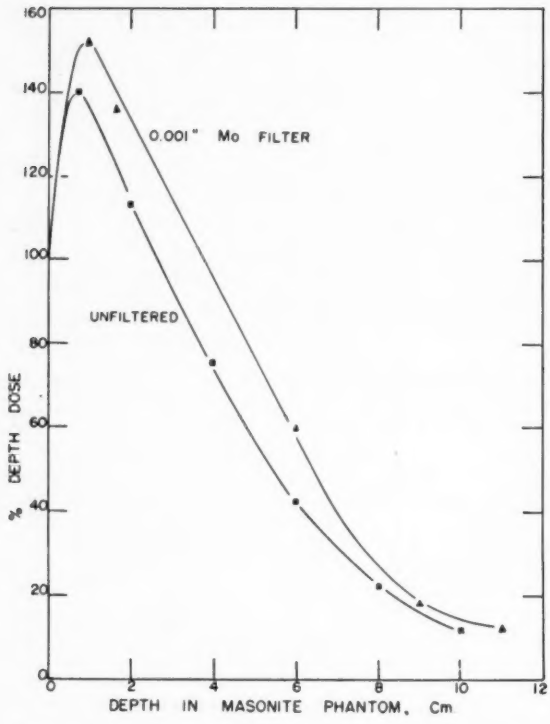

FIG. 8. Depth dose curves obtained with CdS probe for convergent beam roentgen tube (50 kv. operation).

Having passed these preliminary checks, the probes were freely used in obtaining depth dose characteristics of the convergent beam. Being of the thickness of the masonite sheets used in assembling the phantom it was easily built into the phantom structure introducing a minimum of nonhomogeneity. Some depth dose results obtained in this way are shown in Figure 8.

Our results confirm the usefulness of the CdS crystal in roentgen-ray instrumentation particularly where a radiation indicator of extremely small size is desired. It would be relatively simple to build the crystal into a flexible probe a millimeter or so in diameter which might be introduced into the body to give accurate measurement of dosage.

No attempt was made in our work to calibrate the crystals or to check stability against time or total radiation. All indications pointed to such stability, however, as we had no evidence of any decay in sensitivity in the many months of our program. Preliminary tests similar to those described here should be carried out if such probes are to be used at greater intensities and operating voltages than those used in these experiments.

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It is a pleasure to express our appreciation to Mr. R. F. Wilson of the General Electric X-ray Department who furnished the CdS crystals and to Dr. P. A. Riemenschneider for helpful discussions.

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CONVERGENT BEAM ROENTGEN TUBE*

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NUMEROUS methods have been proposed to increase radiation depth dosage values. Using conventional roentgen tubes effective results have been obtained by operation at increased voltage, increase in target skin distance, utilization of filters, rotational therapy and cross fire techniques.

A special tube based on the cross fire idea was proposed by Loebell[1] in 1947. A number of tube elements (cathode and target) were arranged about a common center in a common vacuum chamber. Ports were so arranged that the beams from the various targets converged to a common crossover outside the tube.

A somewhat similar apparatus built in Sweden[3,5] uses a number of cathodes spaced around a central target of conical shape. By collimation, unwanted portions of the radiation are eliminated and the desired beam in the shape of a hollow conical sheath crosses over at a point outside the tube.

In a patent issued in 1949 Frevel[6] describes a tube in which a centrally located cathode emits electrons to the interior face of a target which is in the form of short cylindrical ring. Radiation from this surface is collimated to form a conical sheath.

In 1950 we described a tube[2] having as a cathode a filament axially located within a conical shaped target. The structure is indicated in Figure 1. The radiation pattern to be expected from such a system is shown in Figure 2*a*. In Figure 2*b* a collimating plug has been added and it is seen that the resulting beam is a hollow conical sheath converging to a crossover point outside the tube.

Certain advantages of this type of structure over those referred to above are evident. The electrode structure is such that all

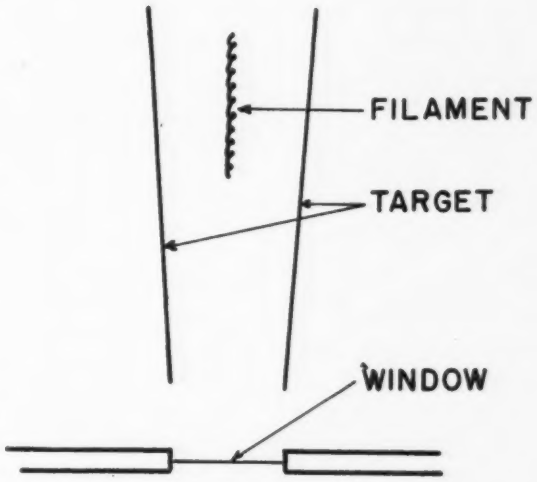

FIG. 1. The relation of the target, coaxial filament and window in the convergent beam tube.

electrons emitted by the filament are drawn to the target without loss and without need of any method of focusing. The extended conical target insures that there will be contributions to the beam from all portions of the target regardless of where the electrons arrive. This extended area of bombardment minimizes target heating and in addition the design is such that cooling is convenient if necessary.

It is seen that we have, essentially, a circular rotational technique built into a fixed tube. Through any plane perpendicular to the cone axis passes a ring shaped beam directed toward a common point.

Some thought must be given to the design parameters of such a tube. The choice of cone angle for the target and position of crossover play an important part in measured performance as do also the operating voltage, the sheath thickness and the absorption properties of the medium traversed by the beam.

For example, the larger the cone angle,

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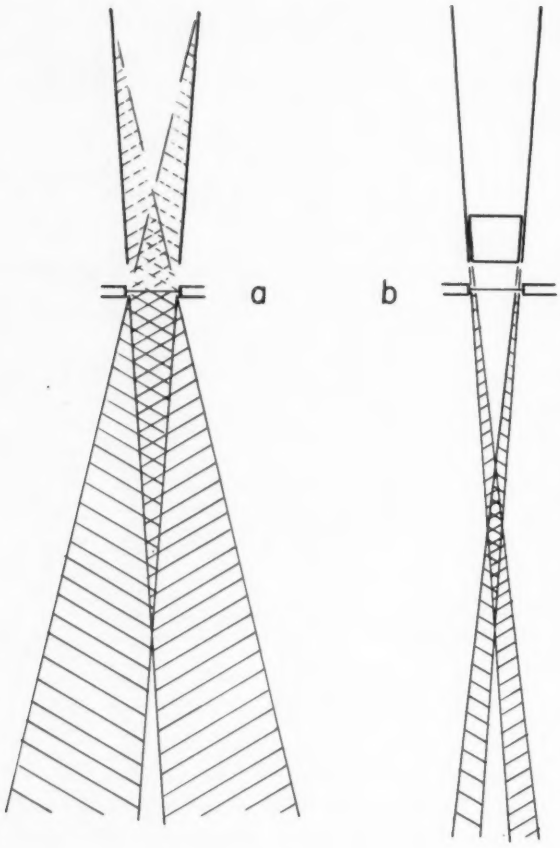

FIG. 2. The pattern of radiation emerging from the small end of a conical target. (*a*) uncollimated, (*b*) collimated by a coaxial conical plug.

the greater the ratio of surface area to crossover area. This in itself would make for increased depth dose values. However, for a given value of depth such increased angle entails greater path lengths in the absorbing medium, or greater depths as "seen" by the beam.

Let us look at how some of the parameters affect the geometrical gain of the tube. Although these effects are not independent of each other, we will discuss their individual actions. Figure 3 depicts a hollow conical sheath of radiation. A geometrical gain in radiation through the crossover arises because all the radiation in the ring in plane A passes through the circle at crossover at plane B. The gain N then is the ratio of the area of the ring to the area of the crossover circle. The area of this ring is:

$$A=\pi(r_2^2-r_1^2) \tag{1}$$

The gain is:

$$N=\pi(r_2^2-r_1^2)/\pi(r_2-r_1)^2/4$$
$$=4(r_2+r_1)/(r_2-r_1) \tag{2}$$

(Progressive thickening of the radiation sheath due to a finite collimator width is discussed later and neglected here.)

Different values of N may be obtained by changing the target cone angle, but for a given tube, N may also vary for different values of sheath thickness and for different different values of d above the crossover point.

For a constant d, the variation of N with sheath thickness may be shown by plotting N against r_1/r_2 as calculated from Eq. (2) (see Fig. 4). Very thin sheaths (r_1 approach-

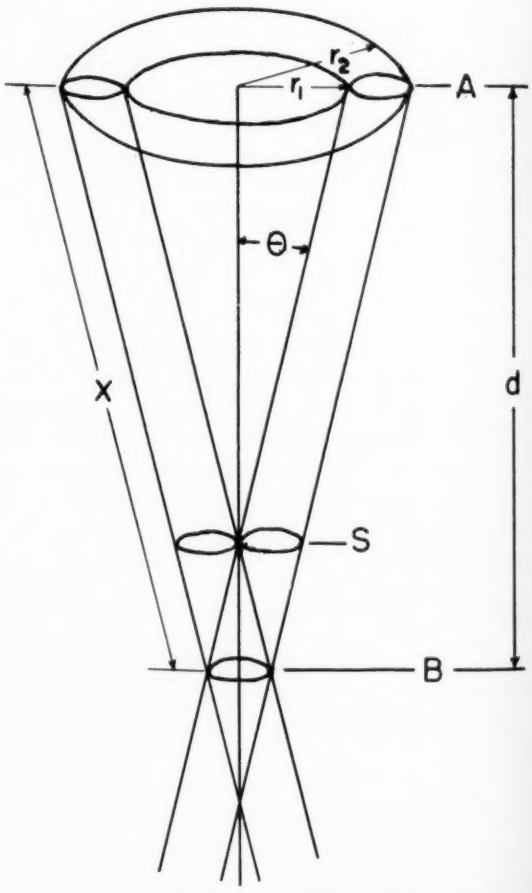

FIG. 3. Geometry of a hollow conical sheath.

ing r_2) reach very high N's. When r_1 is zero, however, N becomes 4. (This corresponds to working at the plane S in Fig. 3.)

For fixed values of cone angle and collimated sheath thickness, N may be plotted against d, the distance above crossover. Using the dimensions of our tube this is shown in Figure 5. (Radiation sheath thickness is still assumed constant here.)

When the sheath thickness is very small (r_1 nearly equal to r_2) (Eq. 2) can be rewritten

$$N = 8r/(r_2 - r_1) \text{ or } 8d \tan\theta/(r_2 - r_1) \quad (3)$$

Now, the actual path length x, of the radiation is greater than d, the vertical distance, since $x = d/\cos\theta$ (see Fig. 3). Thus, increasing the cone angle θ on the one hand tends toward increased geometrical gain (through increased tan θ) and on the other introduces increased absorption (through increased x). Geometrically the unfavorable factor does not increase as fast with increasing θ as does the favorable tan θ factor of gain. In practice, knowledge of the absorbing medium would be necessary to evaluate this situation more exactly.

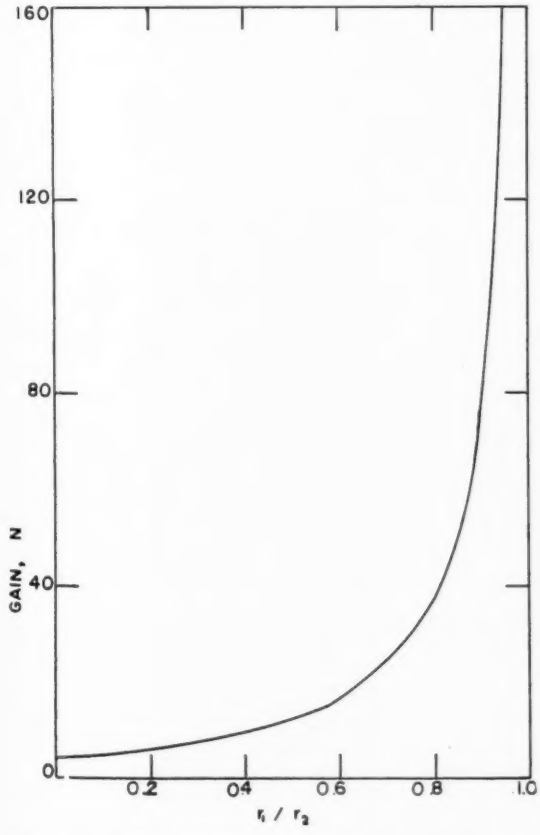

FIG. 4. Curve showing the variation in geometrical gain with sheath thickness (in terms of r_1/r_2).

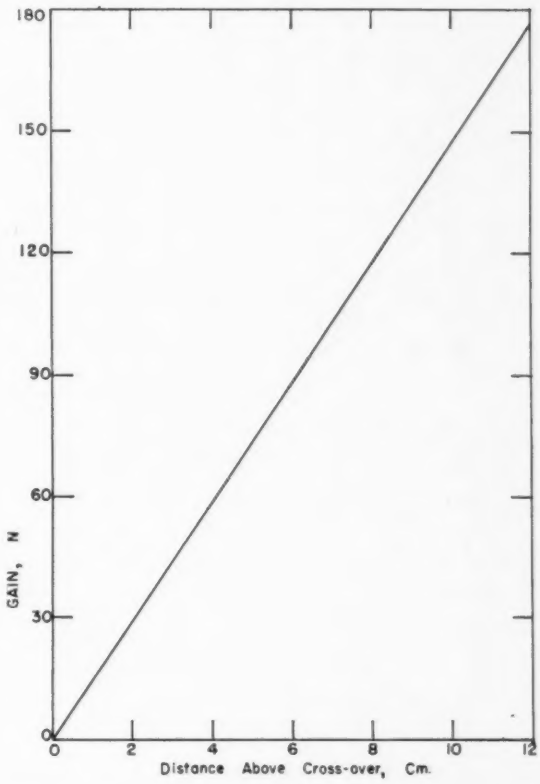

FIG. 5. Curve showing the variation in geometrical gain with distance above the crossover (0.040 inch collimation, total cone angle approximately 8°).

The above considerations have been concerned only with radiation that would leave a target spot and pass directly through the point of crossover. The finite thickness of the sheath makes impossible such an ideal spot focus. The crossover region is seen to be a solid of revolution whose cross section is a diamond shaped parallelogram (see Fig. 3). For small cone angles it is needle-like along the axis, for large angles it becomes more flattened into pincushion shape.

The finite width of the collimator further allows a natural divergence in the "beams" which leave the many individual target

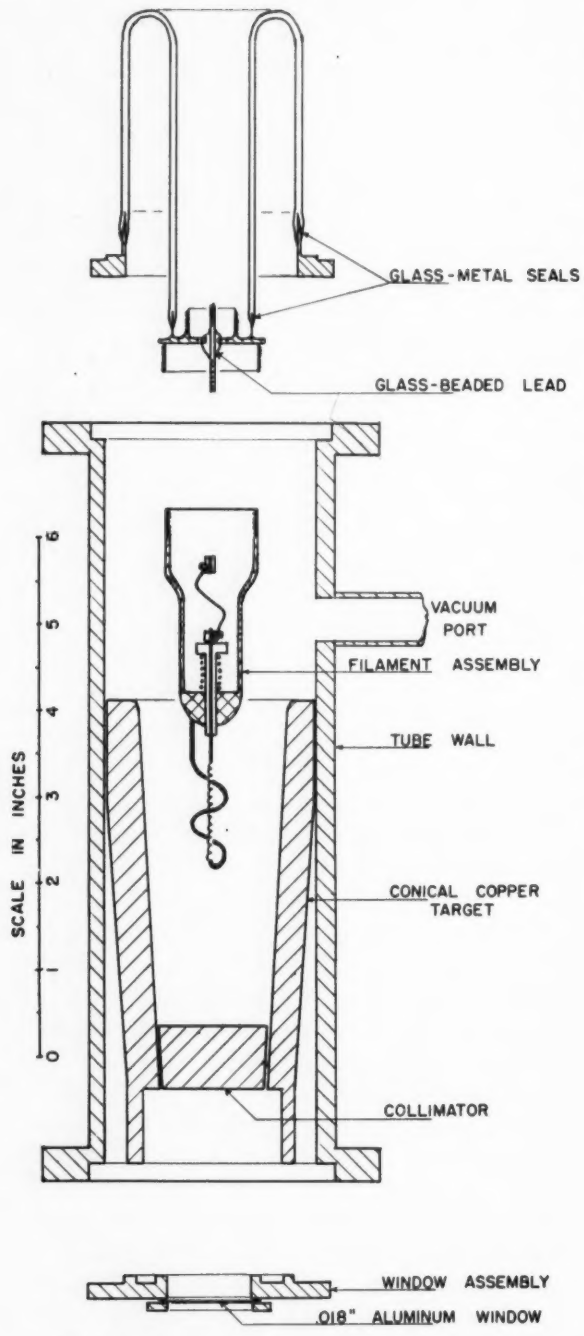

FIG. 6. Diagram of the structure of the convergent beam tube (exploded view).

areas. The radial part of the divergence gives rise to an increase of the sheath thickness which varies linearly with distance from the collimator and which contributes to the crossover region above mentioned. The divergence in directions other than radial contributes to a halo-like background the extent of which varies with the sheath thickness. We call this skew radiation.

The concentration of this skew radiation is greatest nearest the tube window and it disperses radially with distance. There is, of course, none at the exact crossover point itself.

These factors of divergence may be minimized by the use of a very thin beam sheath. We have collimated down to 0.25 mm. over a 20 mm. length. Closer spacing requires precision machining and provision for distortion under operating temperatures. The skew radiation may be further minimized by the use of radial collimating fins. Sievert *et al.* approximately doubled their depth dose values (at about 200 kv. operation) by the use of such radial collimation.

The interlocking nature of these parameters as well as the various possibilities in absorption made it undesirable to try to work out a general relation that might indicate optimum design.

FIG. 7. Photograph of the emergent beam in air. The film was placed in a plane through the beam axis.

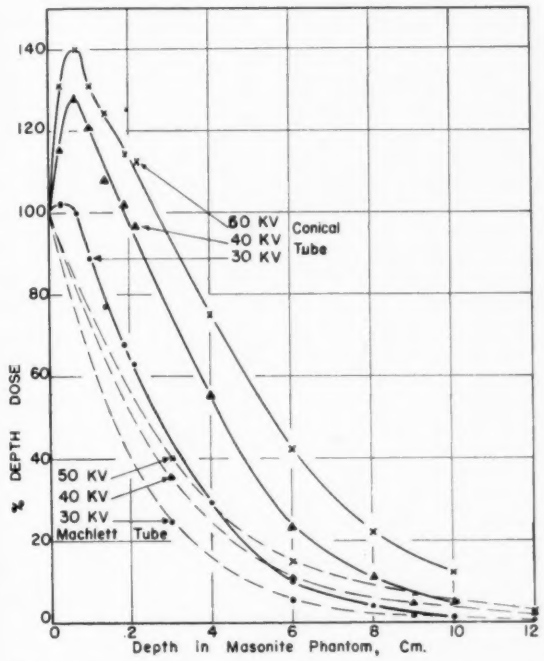

Fig. 8. Depth dose curves for the convergent beam tube and for a Machlett CYR-B tube at the same voltages. Filtering was arranged so that the half-value layer values were the same for both tubes.

To date our work has been concerned with evaluating the performance of such a tube as evidenced by depth dose data. The tube structure is assembled as a continuously pumped device. The general details are shown in Figure 6. The power supply uses half wave rectification with a surge resistor of 700,000 ohms in series with the tube.

The demountable nature of the tube makes it impossible to outgas the tube elements and surge free operation is not always possible at voltages above 55 kv. For this reason some of the data are restricted to values below this. At high energy dissipation the tube was cooled by forced air from a blower. Figure 7 shows a cross section of the beam in air obtained by placing the film in a plane containng the axis of the cone.

Usual intensity measuring instruments require volume immersal of the chamber in the radiation flux. With this tube such volume immersal is impossible—available

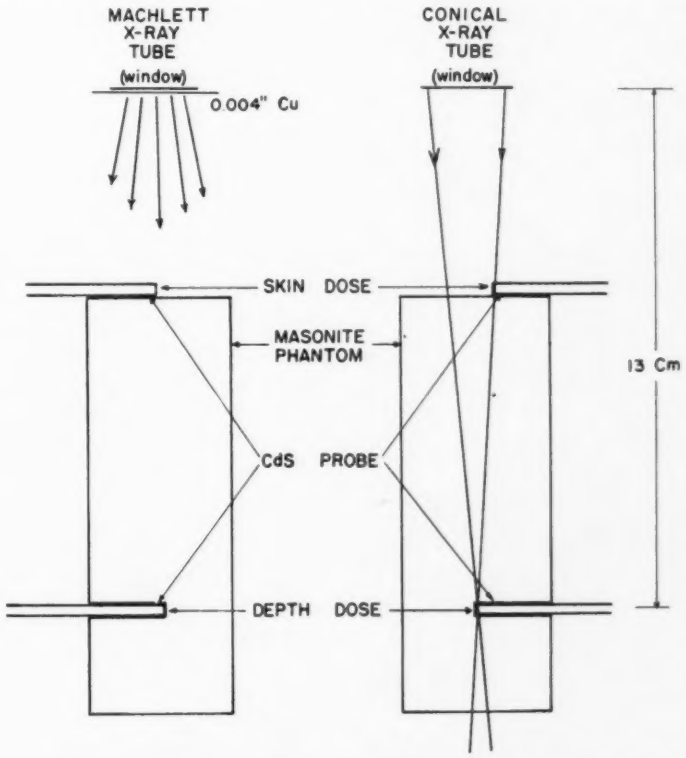

Fig. 9. Experimental arrangement used in obtaining the data for Figure 8.

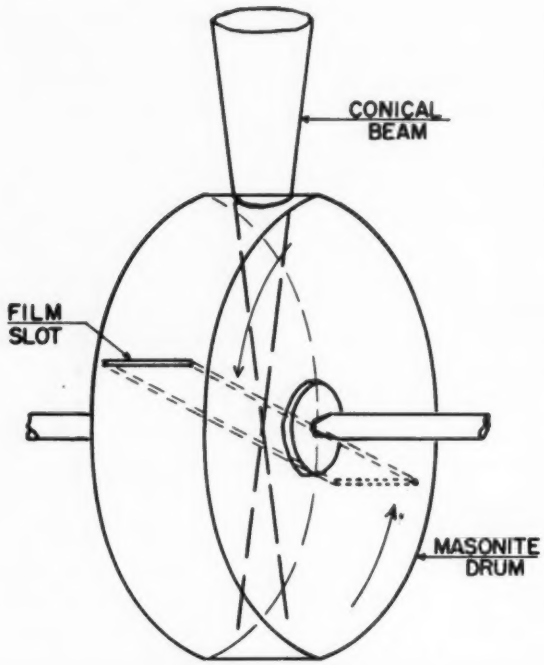

FIG. 10. Arrangement of film in cylindrical phantom for rotational experiments.

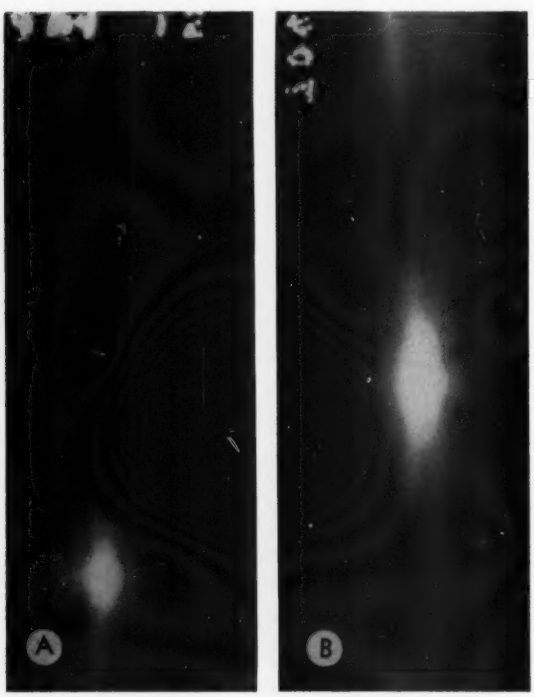

FIG. 11. Film from rotating cylindrical phantom (60 kv., 0.001 inch moly. filter). (*A*) Cylinder radius 12 cm. (*B*) Cylinder radius 6 cm.

chambers are all larger than the beam dimensions. Our first approach in obtaining depth dose information involved photographic densitometry techniques. Later in the program we developed a tiny probe using a CdS crystal. This probe, described elsewhere[1] expedited the work immeasurably.

Figure 8 shows the depth dose curves taken at 30, 40, and 50 kb. for various depths in masonite phantoms. For comparison at these relatively low voltages, similar curves were obtained using a Machlett Type CYR-B tube with tungsten target. The crossover of the convergent beam tube set the far point for the measurements at about 13 cm. Masonite was added between this point and the tube to get greater d values (Fig. 9). The same pro-

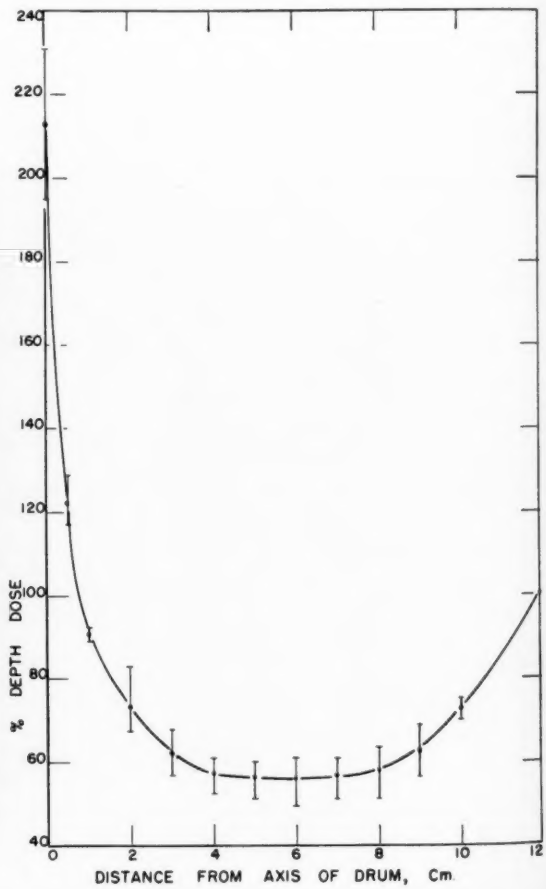

FIG. 12. Depth dose curves for rotational phantom (12 cm. radius 60 kv., 0.001 inch moly. filter).

cedure was used in connection with the data from the Machlett tube. At 50 kv. the half-value layer for the experimental tube is 3 mm. Al. The half-value layer of the Machlett tube was made equal to this by using 0.004 inch copper in the beam.

Since the convergent beam tube lends itself perfectly well to rotational therapy techniques, data were obtained for such conditions. Built up cylinders of masonite were arranged to rotate about an axis accurately placed on the beam crossover (Fig. 10). A film placed on a diametral plane recorded the radial distribution of intensity in the cylinder. Film from such exposures at 12 and 6 cm. depths are shown in Figure 11 and depth dose data are given in Figure 12. These data were, of course, obtained by densitometry since use of the crystal was impractical.

The tube design is such as to lend itself to ordinary tube manufacturing practices. The higher voltage operation possible with such processed tubes should bring the usual proportional gains in performance. That this may be expected is seen in the curves of Figure 8 and is also indicated by some data we have for 60 and 70 kv. operation.

The authors are pleased to acknowledge the contributions of S. Silverman and H. Berger who were active in the early stages of the program and are also grateful to Mr. R. F. Wilson of the General Electric X-ray Department who supplied the CdS crystals used in developing the intensity probe. They are especially grateful to Dr. Paul Riemenschneider and Dr. Arthur Ecker for many helpful discussions.

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SOME TECHNIQUES IN THE UNDERGRADUATE TEACHING OF DIAGNOSTIC ROENTGENOLOGY

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DURING the past five years a number of innovations have been made in the teaching of diagnostic roentgenology to medical students at the University of Cincinnati College of Medicine. Because of the interest expressed in some of these newer methods, a description of the techniques and of our experience with them is offered here. It is hoped that this may prove of interest to others concerned with medical education.

No claim is made to originality in the introduction of these methods. In fact, many of the ideas grew out of stimulating discussions with Dr. Irving Robbins, formerly of the Teachers College of the University of Cincinnati and now Assistant Professor of Education at Queen's College, New York City.

The present curriculum in diagnostic roentgenology, taken from the College of Medicine catalog, is shown in Table 1. The required courses in the second and fourth years are given to the entire class (84 students). The third year required and elective courses are repeated in each quarter. Nearly all of the members of the senior class enroll for the elective in the final quarter of the fourth year. In most courses reaction of the student is tested by a questionnaire which he fills out and returns, unsigned, at the final session.

In addition to the roentgenology courses listed in the catalog, many individual lectures and film presentations are given by members of the Department of Radiology under the auspices of the Departments of Anatomy, Physiology, Pathology, Medicine, Surgery, and others.

This allotment of time to the undergraduate teaching of diagnostic roentgenology is justified, we believe, on the following grounds:

(1) The increasing role played by roentgenology in modern medicine makes it essential that all physicians learn to use this diagnostic tool more effectively and with clearer understanding than in the past.

(2) A considerable amount of clinical medicine can be taught in a course in diagnostic roentgenology if emphasis is placed on the broader aspects of the subject rather than on the fine details of roentgen interpretation.[2]

(3) A visual method, uninhibited by the limiting boundaries between specialties, is an effective teaching instrument. As Rigler[3] has pointed out, "Roentgen diagnosis is unique among the specialties—it cuts squarely across all the divisions in medicine." Let us take, as an example, the disease *scleroderma*. Its effects on bone, lung, heart, and gastrointestinal tract can be tied together forcefully in the mind of the student by a well illustrated discussion of its roentgen manifestations. Roentgenology, therefore, provides a tangible means of establishing a comprehensive outlook on a medical subject.

Before proceeding with a description of the chief innovations in our teaching program, it should be pointed out that, wherever possible, the classes are divided into small groups in which emphasis is placed on student participation rather than on didactic lectures. Original films are used in the small group discussions and the direct film projector for the large groups. We prefer these to slides because of the wider selection of material, the ease of introduction of current cases, and the lower cost.

1. *Closed Door Session.* This exercise, under various names, is widely used by college and other discussion groups. The usual sequence is: (1) a lecture on a controversial subject; (2) division of the audience into

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Table I

	Required Courses	Hours	Elective Courses	Hours
Sophomore	Introduction to Radiology	16		
Junior	Essentials of Roentgenology	9	Roentgenology of the Lung*	4
			Roentgen Diagnosis in Pediatrics*	5
			Roentgenology of the Abdomen	9
Senior	Applied Roentgenology	18	Roentgenology Workshop	9

* Combined course.

small groups, each of which elects a spokesman; (3) discussion of the lecture subject by each group; and (4) presentation of his group's viewpoint to the entire audience by each spokesman.

Our adaptation of this exercise receives its name from the absence of an instructor in the discussion groups, and is used in the senior required course (Applied Roentgenology). The previous hour having been devoted to an illustrated lecture on some region of the body, the following week the students are divided into groups of 10 or 12 as they arrive for the class. Each group then elects a spokesman and goes to one of eight rooms where a viewbox and films on a current case await it. Some of the cases are selected to illustrate particular points in the preceding week's lecture while others are chosen to bring out new information or to stress differential diagnosis.

Clinical information is presented, but is limited to that necessary for an intelligent discussion of the case. The student spokesman leads the discussion and guides the group toward a logical diagnosis, permitting each of his fellow students, in turn, a chance to express himself. A bit of cautious eavesdropping provides convincing evidence of the uninhibited nature of the discussion.

After fifteen minutes of this activity all students report to the main classroom, where each spokesman, utilizing the direct film projector, presents his case to the entire class, reporting the roentgen findings and expressing his group's majority and minority opinions with the reasoning behind them. After each presentation the instructor gives a concise critique. The following week the instructor lectures on a new subject, providing more background for the next *Closed Door Session.*

A significant disadvantage of this method is that it curtails the quantity of material which can be presented in the course, since the total lecture time is reduced to one-half. However, the student, by his active participation, gains a more thorough grasp of the subject and profits greatly by the opportunity for self-expression. Replies to the questionnaire indicate enthusiastic endorsement by the students.

2. *Roentgenology Workshop.* This nine-hour senior elective course is attended by about 75 students. The purpose of the course is to equip the student with sufficient understanding of the potentialities and limitations of roentgenology to use it to the fullest advantage.[1] The class is subdivided into seven permanent groups which rotate through different subjects. These consist of the following: Chest Fluoroscopy, Gastrointestinal Fluoroscopy, Roentgen-Ray Technique, Film Reading, Film Analysis, Library Orientation, and Library Report. Instructors are selected from among the radiology residents.

At the two *Fluoroscopy* sessions either a hospital patient or one of the students is used as the subject. No attempt is made to study pathological material, but the value and limitations of fluoroscopy are discussed and emphasis is placed on such fundamentals as radiation hazards and their prevention, adequate dark adaptation, small screen aperture, and the use of spot films.

In the session devoted to *Roentgen-Ray*

Technique, films are exposed and carried through the processing procedure. Again, details of roentgenography are avoided and stress is placed on the value of adequate information for the technician, on meanings of certain technical terms, on the proper handling of wet films, and on a general understanding of the problems encountered behind the scenes in a busy roentgen department.

In *Film Reading* the students sit behind the instructor while he dictates reports on unselected films from the preceding day. They are encouraged to interrupt with questions and comments. This activity is aimed primarily at impressing the student with the need for adequate clinical information in roentgen interpretation.

In *Film Analysis* the instructor utilizes roentgenograms in which the significant lesion is inconspicuous, requiring a thorough search of the film for its detection. A minimal pulmonary tuberculous focus, a small "coin" lesion, a mass behind the heart, a destroyed segment of rib—any of these makes excellent material. A student is called upon to read the film. If he fails to find the significant shadow, the other members of the group are given an opportunity. Considerable over-reading generally results. This approach emphasizes the importance of a thorough study of the roentgenograms and also stresses the value of a knowledge of the normal roentgen appearance.

In *Library Orientation* the student is first briefed by the medical librarian on the use of the library; he then looks up an assigned topic. At the *Library Report* class he presents a five minute talk on the subject to his group in the presence of an instructor. Constructive criticism is then given by his audience. These exercises have been rather unpopular with the students and are to be omitted in the coming year. Typical complaints were, "Earlier courses in library orientation make it unnecessary," and "It takes too much time out of the course."*

Although no formal grade is given for the course, several examinations and grading methods have been tried so far, with indifferent success. Our first method consisted of giving two quizzes, one at the first session and the other at the end of the course, the same examination films being used in both. This was originally designed to test the "growth" of the student, but it soon became apparent that the instructor unconsciously tended to be more lenient on the second quiz than on the first, thus defeating his purpose. The method was discarded.

We next adopted a type of grading which is said to be more helpful to the student in evaluating his own work than conventional methods. A separate grade was given for under-reading (errors of omission), over-reading (errors of commission), judgment, and factual information. This method was found to be difficult and very time consuming for the instructor, and the results are probably inaccurate because of the small number of tests. Further experience in the area of evaluation of the student and of teaching methods is essential before valid conclusions can be drawn.

Except for the library assignment, the *Roentgenology Workshop* has proved to be well received by the students, as demonstrated by questionnaire and enrollment.

3. *Case of the Week*. This exercise has proved extremely popular, not only with students of the junior and senior classes, but also with interns, residents, and visiting staff. A series of four viewboxes is set up in the Roentgen Department hallway, which happens to be one of the main corridors of the hospital. One or two films from a proved case are placed on the viewbox and a small amount of clinical history is appended. The case is carefully selected from the teaching file to illustrate a more or less diagnostic roentgen appearance, *e.g.*, scurvy, rickets, obstructive pulmonary emphysema, gout, tuberculosis of the spine,

* We have since substituted for these a session on radiation therapy and one entitled *Teamwork*. The latter is a conference in which the need for close cooperation between the clinician and radiologist is stressed, using concrete examples, and includes a discussion of cost of operation of a radiology department.

etc. A pad of paper and a locked mailbox are conveniently at hand. The student (or physician) is encouraged to write his diagnosis, sign his name, and deposit the slip in the mailbox. A week later the answer sheet is posted alongside the films, and a new case is published on the remaining viewboxes. The answer sheet is composed by the chief resident and includes the correct diagnosis, several paragraphs of discussion, a few pertinent references, and the names of the winners, each of whom is rewarded with five cents in cash on application to the department secretary. While no special attempt is made to "stump" the students, we avoid the easy cases for obvious reasons. On occasion we have underestimated our students, to our financial embarrassment. On the other hand, once a student facetiously touted the wrong diagnosis and twenty identical but incorrect answers appeared in the mailbox.

From 30 to 40 individuals submit a diagnosis each week but well over a hundred study each case. The hallway is invariably congested the day the answer is published and the new case posted.

4. *Film Library*. Each week about 15 cases from the teaching file are placed in one corner of the Radiology Department library for the benefit of those students who have the time and inclination to study them. Although the legends on the film envelopes are self-explanatory, a radiology resident or staff member is usually available for consultation. The film library is advertised by classroom announcements and by signs in the Radiology Department. From four to eight students sign the film library register each week. Books and journals in the Radiology Department library are also occasionally used by the students, but they are not permitted to take them out of the Department.

5. *Conferences*. A list of the roentgenologic conferences is conspicuously posted adjacent to the *Case of the Week* and students are invited to attend them. These conferences include the daily radiology residents meeting and weekly interdepartmental sessions with the Surgical, Medical, Gastroenterology, Orthopedics, Urology, Neurology, and Pediatrics Departments. Best attended by the students are the conferences with the medical and surgical house staffs, in which films are reviewed on ward cases already familiar to the student in his capacity of ward clerk. Students are also encouraged to consult individually with members of the Radiology Department on their assigned ward cases.

DISCUSSION

Following the trend in modern teaching, the methods described above are based on small group activities. The permissive atmosphere of such groups encourages informal spontaneous discussion and uninhibited thought and expression. Since formal grades in roentgenology are not given, motivation must rest upon the recognition by the student of the importance of diagnostic roentgenology in present-day medicine, and upon the creation and maintenance by the department of a sustained interest in the subject matter. In the latter connection considerable thought must be given to the selection of the case material for the various exercises. A selective and discriminating combination of dramatic and mundane cases appears most appealing to the majority of students.

The students themselves have responded enthusiastically. Enrollment in almost all of the elective courses has been near capacity, and attendance in the required courses, despite the omission of a roll call, has been excellent. Replies to the questionnaires were extremely favorable to most of the exercises, with the *Closed Door Session* and *Case of the Week* leading in popularity.

Some of these techniques have enjoyed wide success in nonmedical fields. As our experience shows, they can be adapted to medical teaching as well, not only in diagnostic roentgenology but also in other subjects. An approach of this sort is also possible in the training of interns and residents, even in hospitals having no univer-

sity connection. The stimulation of such a program might help to ensure an adequate selection of candidates for internships and residencies.[4]

The quality of teaching in medical colleges could be improved by making pedagogical training available to the teachers. Proficiency in a particular field is too often the only requirement of an instructor with important teaching responsibilities. A voluntary course for the medical faculty, in which successful teaching methods are described and practical problems discussed, would be an important step in the right direction. Those of us who have had no training in teaching methods must, if we are not to fumble our way in the dark, consult with experienced specialists in this field and adapt their techniques to our needs. The results of such consultation cannot help but be beneficial.

ADDENDUM

Since this paper was submitted we have acquired an exhibit viewbox and have installed it in the department corridor. Exhibits of various roentgen subjects of general medical interest are inserted and changed about every two months during the school term.

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A ROENTGENOGRAPHIC AID TO THE DIAGNOSIS OF RADIOPAQUE FOREIGN BODIES IN THE UPPER INTRATHORACIC ESOPHAGUS*

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THE roentgenologic identification of opaque foreign bodies in the cervical portion of the esophagus usually is made on plain lateral roentgenograms of the neck. However, when such objects are situated at or just below the level of the thoracic inlet, their visualization may be difficult. Patients with symptoms referable to this area sometimes achieve a false sense of security from a so-called negative roentgen examination. The procedure to be described here aids in the investigation of the 3 or 4 centimeters of the esophagus which at rest is located below the level of the sternal notch.

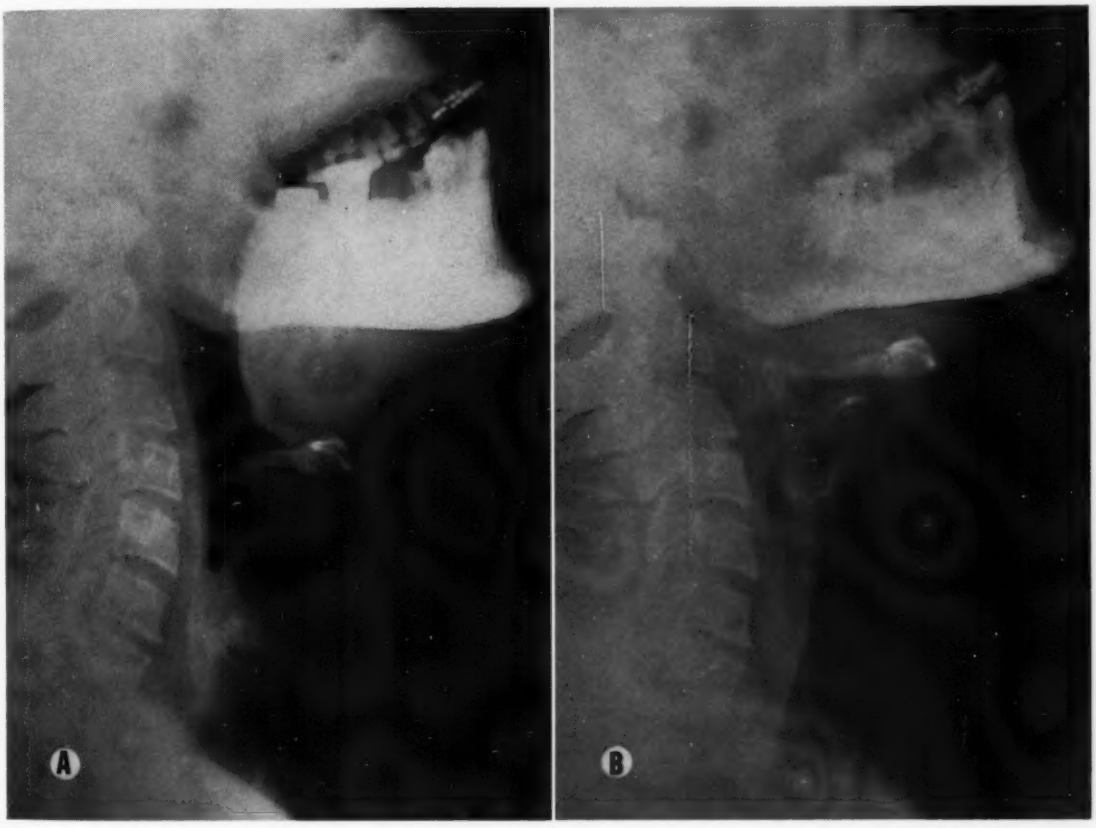

FIG. 1. (*A*) Lateral neck roentgenogram of an adult male. The cricoid cartilage is at the level of the body of the seventh cervical vertebra. (*B*) Same patient as in (*A*). Exposure is made at the height of deglutition. The cricoid cartilage is now at the level of the fifth cervical vertebra.

On lateral neck roentgenograms with the patient suspending respiration the posteroinferior margin of the cricoid cartilage is at the level of the body of the sixth or seventh cervical vertebra. During the swallowing act the cricoid rises for a distance corresponding to the height of approximately

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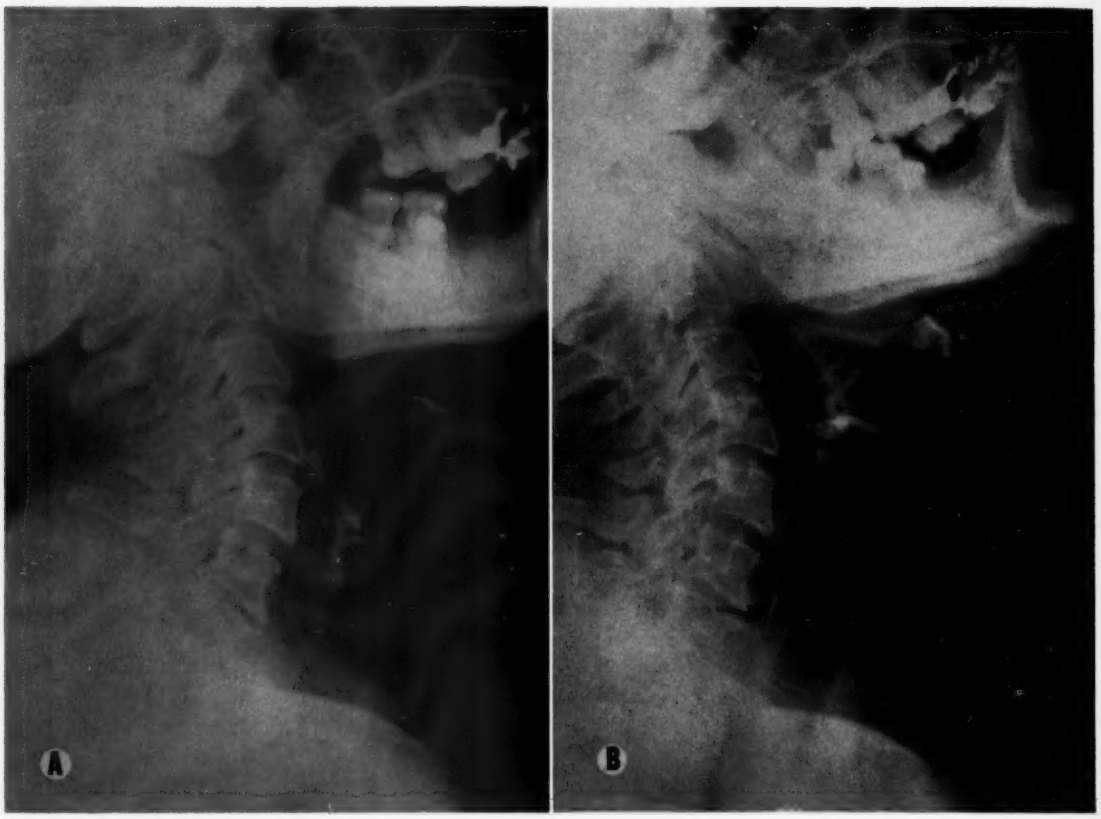

FIG. 2. (*A*) Lateral neck roentgenogram of an adult female. The retrotracheal tissues in the lower neck show no foreign body. The cricoid cartilage is at the level of the seventh cervical vertebra. (*B*) Same patient as in (*A*). Exposure is made at the height of deglutition. A foreign body is seen in the esophagus (arrow) at the level of the interspace between the sixth and seventh cervical vertebrae. The cricoid cartilage is at the level of the interspace between the fourth and fifth cervical vertebrae.

two cervical segments, and this in turn elevates the uppermost portion of the intrathoracic esophagus an equal distance (Fig. 1*A* and *B*).

The first stage of swallowing is under voluntary control. A short inspiration precedes the initiation of deglutition, followed by cessation of respiration which persists until the end of the second stage in which the bolus is directed down the pharynx. It has been estimated that food reaches the upper esophagus about one second after swallowing begins.

During swallowing the back of the tongue is pressed against the hard palate by the action of the mylohyoid muscles, thereby forcing the bolus into the pharynx. The hypoglossal, glossopalatine and styloglossal muscles act in unison to pull the tongue upwards and backwards directing the food through the pharynx into the upper esophagus. Here the second stage supervenes in which the constrictor pharyngii muscles propel the bolus into the esophagus while the palatopharyngeus and stylopharyngeus muscles draw the pharynx upwards over the bolus. Passage of food into the larynx is prevented by contraction of the thyrohyoideus muscles which elevate the larynx, bringing its opening under cover of the epiglottis and the root of the tongue. It is this elevation of the larynx which brings the upermost 3 or 4 centimeters of the thoracic esophagus into view.

In preparation for the roentgenologic examination of the neck with the swallowing maneuver, the patient is instructed to collect some saliva on the back of his tongue

to serve as a mechanical stimulus for the swallowing mechanism. He is then positioned for a lateral roentgenogram of the neck, and the head is tilted slightly backwards so that the movement of the thyroid cartilage may be observed easily. He is then instructed to swallow slowly, thereby familiarizing himself with the process of bringing the thyroid cartilage as high as possible. It sometimes helps to let the patient place his finger on the superior notch of the thyroid cartilage while he swallows. The optimum time for making the exposure is when the thyroid cartilage reaches its maximum height in swallowing. With a little practice patients can be shown how to sustain that portion of the act of swallowing for a few seconds.

Our present technique in suspected foreign bodies of the uppermost portion of the intrathoracic or the lower cervical esophagus is to take a routine lateral roentgenogram of the neck. If the suspected object is found, the study is discontinued. If, however, nothing is evident on this film the next step is to obtain lateral neck roentgenograms at the height of deglutition.

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A NEW RULER-GRAPH FOR LOCALIZATION OF THE PINEAL BODY*

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IN 1927 Vastine and Kinney[6] published their classical work on the "Pineal shadow as an aid in the localization of brain tumors." Their two charts, with Dyke's[2] modification in 1930, have served radiologists and neurosurgeons faithfully as an objective aid. In 1937 and 1938, Fray[4,5] presented two other methods for orientation of the pineal body: (1) the proportional method, utilizing a localizer made of an elastic band, and (2) the cranio-angle method, utilizing a transparent guide with two predetermined angles as the localizer. In 1933 Camp[3] constructed a metal cylinder based on the Vastine-Kinney charts, the working of which depended on proportional uniform expansion of the coil when put on stretch. The latter three methods are not satisfactory. After considerable experience, Davidoff and Epstein[1] have found that the most reliable method of measuring the pineal shadow is the Vastine-Kinney technique with Dyke's modification.

Since 1949, I have been closely associated with a very active neurosurgical service (Dr. Leo M. Davidoff). Measurement of the pineal shadow has been a very important part of the roentgen examination. Although it is a simple procedure to make the required measurements with an ordinary centimeter rule and then to plot these points on the Vastine-Kinney charts, it became apparent that there is need for a single ruler to apply to the skull roentgenogram with which one could determine pineal displacement at once. Such a

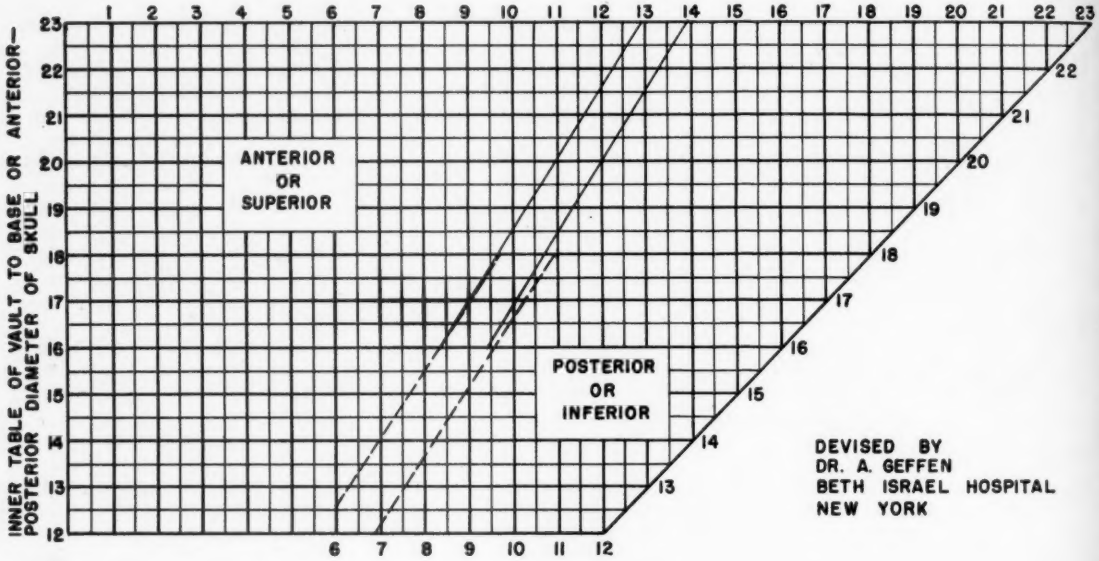
INNER TABLE OF VAULT TO BASE OR ANTERIOR–POSTERIOR DIAMETER OF SKULL
ANTERIOR OR SUPERIOR
POSTERIOR OR INFERIOR
DEVISED BY DR. A. GEFFEN BETH ISRAEL HOSPITAL NEW YORK
DISTANCE INNER TABLE OF FRONTAL BONE OR VAULT TO PINEAL
CENTIMETER SCALE FOR PINEAL BODY LOCALIZATION IN BOTH ANTERIOR–POSTERIOR AND VERTICAL PLANES (BASED ON CHARTS BY VASTINE & KINNEY, WITH DYKE'S MODIFICATIONS)

FIG. 1. Photograph of the new ruler-graph for localization of the pineal body.

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Fig. 2. Lateral roentgenogram of the skull with the new ruler-graph in place to locate the pineal body in the anteroposterior plane. The pineal falls between the solid diagonal lines; therefore, it is in the normal zone. (Pineal shadow on roentgenogram has been retouched for photographic reproduction.)

ruler was devised and has been found to be both accurate and useful.

The ruler (Fig. 1) is essentially a combination of the two Vastine-Kinney charts (with Dyke's modification) plotted to scale on a half-centimeter graph. From those charts, the normal zones are plotted. For the anteroposterior plane, the abscissae and ordinates are the same on the ruler as on the charts. For the vertex-base plane, the abscissae and ordinates of the Vastine-Kinney charts are reversed for the new ruler. This simple departure enables one to plot the normal zones for the two planes on a single graph with only a short segment of the zones overlapping. However, the

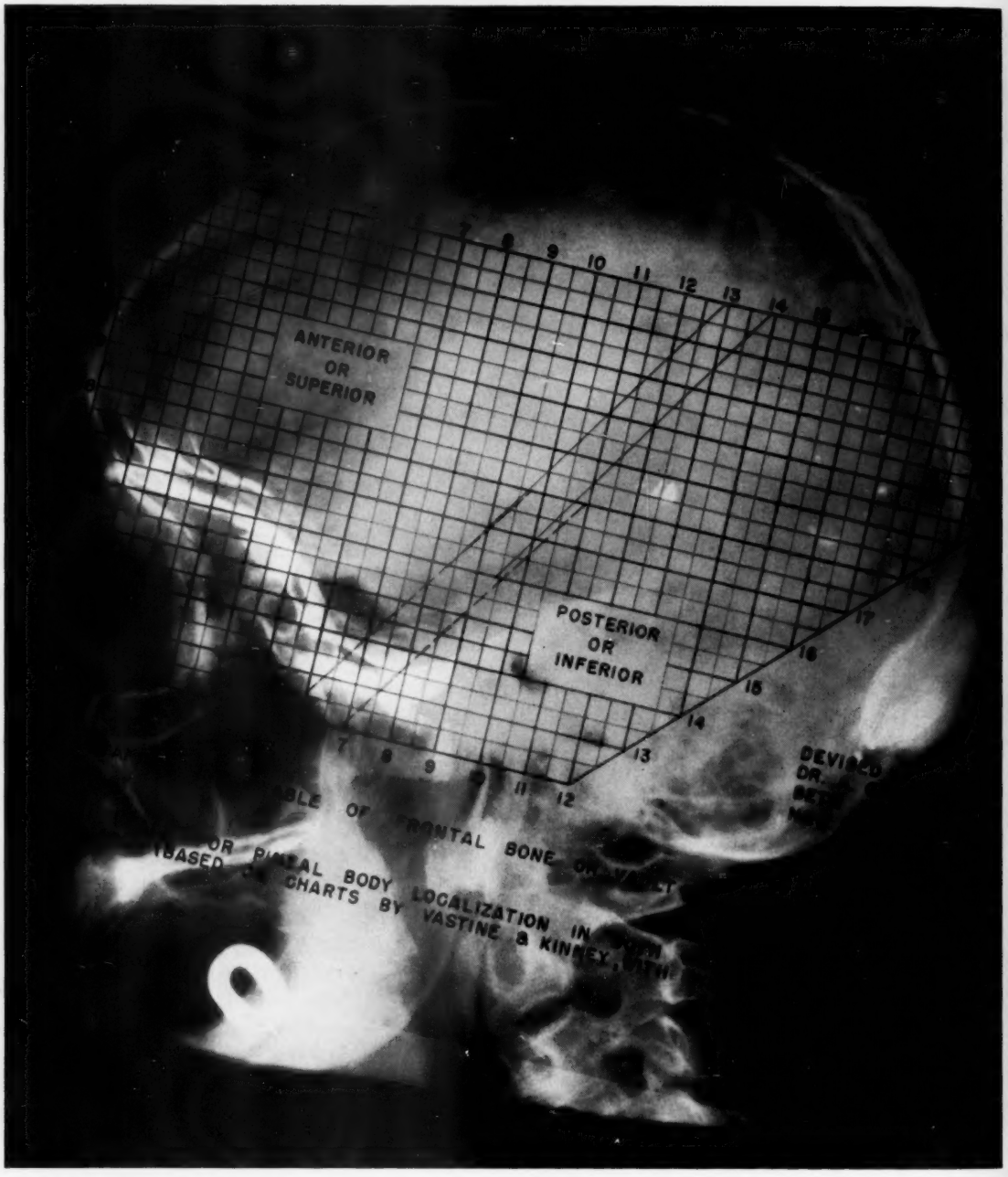

FIG. 3. Lateral roentgenogram of the skull with the new ruler-graph in place to locate the pineal body in the anteroposterior plane. The pineal is 1.5 centimeters posterior to the normal zone. The posterior displacement is due to a frontal tumor proved at exploration. (The pineal shadow has been retouched for photographic reproduction. The opaque material in the occipital region remains from a previous cervical myelographic study.)

overlapping is easily distinguished by the use of solid lines as the boundaries for the normal zone in the anteroposterior diameter and dotted lines for the vertical plane.

The second important principle of the ruler is that each half-centimeter point on the ordinate line is extended as a line on the graph horizontally for a distance corresponding in centimeters to that point. These lines begin at 12 centimeters and

FIG. 4. Lateral roentgenogram of the skull (same patient as in Fig. 2) with the ruler-graph in place to locate the pineal body in the vertical plane. The pineal shadow falls between the dotted diagonal lines; therefore, it is in the normal zone.

end at 23 centimeters. A diagonal line, joining the ends of the 12 and the 23 centimeter lines and passing through the ends of all of the intervening half-centimeter horizontal lines, thus forms the right margin of the ruler, These lines correspond to the range of values for the total diameter of the skull in the two planes as on the original Vastine-Kinney charts. The left margin of the ruler is the combined ordinate line for the two charts, with points 12 to 23 centimeters indicated at half-centimeter intervals. These points are also true zero for each of the horizontal lines at half-centimeter intervals. The upper margin of the ruler is the 23 centimeter diameter

line. It also serves as a true centimeter ruler for measuring the specified diameters and as a guide to mark the points on the skull from which the measurements are taken.

The ruler is used as follows:

Place the skull roentgenogram to be measured on the view box with the frontal bone directed to the observer's left.

A. To measure anteroposterior displacement:

1. Using the upper margin of the ruler, measure the greatest anteroposterior diameter of the skull which passes through or as nearly as possible through the pineal shadow. Mark with film crayon the zero point on the inner table of the frontal bone and the most distant point on the inner table of the occiput. The pineal shadow can also be marked on the film if it is very faint. Let us assume the measurement is 19 centimeters.

2. Place the ruler so that the 19 centimeter point on the left margin of the ruler coincides with the zero point marker (in step 1) on the inner table of the frontal bone, and the end of the 19 centimeter line on the right margin of the ruler coincides with the marker (from step 1) on the inner table of the occiput.

3. Locate the pineal shadow through the transparent ruler and see its relationship to the two parallel solid diagonal lines demarcating the normal zone. If the pineal falls between the diagonal lines, it is in the normal position (Fig. 2). Anterior or posterior displacement can be seen at once and measured (Fig. 3).

B. To measure the vertical displacement:

1. Using the upper margin of the ruler, measure the distance from the inner table of the vault to the base of the skull at the level of the foramen magnum on a line which passes through the pineal shadow. Mark the zero and base points on the film with crayon. Assume the measurement is 16 centimeters.

2. Place the ruler so that the 16 centimeter point on the left margin of the ruler coincides with the zero marker on the film and so that the end of the 16 centimeter line on the right margin of the ruler coincides with the marker on the film at the base of the skull.

3. Locate the pineal shadow through the transparent ruler in relation to the two parallel dotted diagonal lines delimiting the normal zone for the vertical plane. Superior or inferior displacement can be seen at once and measured (Fig. 4).

Inasmuch as the upper margin of the ruler is a simple centimeter ruler, lateral displacement of the pineal as determined from the posteroanterior roentgenogram of the skull can also be measured.

SUMMARY AND CONCLUSIONS

A new transparent centimeter ruler-graph, combining the two Vastine-Kinney charts with Dyke's modification, is described. The ruler enables one to visualize and determine accurately pineal displacement in all three planes at once by placing the ruler on the skull roentgenogram without further reference to the original charts.

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I am indebted to Mr. John H. Wilcox, Mr. C. F. Clark, and others of the Photo Products Department of E. I. Du Pont de Nemours and Company for their aid and advice in devising the final model of this ruler-graph. I also thank Mr. Wilcox and Mr. Richard Cook of the same office for the illustrations. The ruler-graph is not yet available but inquiries concerning it may be addressed to the author.

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EDITORIALS

SUPERVOLTAGE RADIATION THERAPY WITH ROENTGEN-RAY AND GAMMA-RAY BEAMS

NEARLY a quarter of a century has elapsed since supervoltage radiation therapy was introduced for the treatment of cancer and allied diseases.

The first attempts were made by using roentgen-ray beams produced by electrically operated apparatus. The aim was to extend the range of the so-called "deep" roentgen therapy with 200 kv., the most common form of treatment at that time, and, in order to create a distinction, the name of "supervoltage" was coined for the form of roentgen therapy with energies above 250 kv.

As was to be expected, the progress in the beginning was extremely slow. The many difficult problems involved in the construction of increasingly powerful electrical apparatus, the enormous size of these apparatus and the great expense necessary for their operation were important factors, which limited the use of supervoltage roentgen therapy to a few large institutions. Only after World War II, following radical changes of design in the newer units, did this form of therapy find wider acceptance.

As conceived originally, no upper limit was placed on the range to which supervoltage roentgen therapy could be extended. With the advent of the betatron and other similar apparatus, however, it became evident that at very high energies, in the field of the so-called "megavoltage" roentgen therapy, an entirely different situation arises which makes a distinction from this type of irradiation also desirable. From the physical standpoint it is impossible to determine accurately where the lower and upper limits of the range of supervoltage roentgen therapy are, for the transition in both directions is gradual. Clinical experience, however, shows that for various reasons the range of from 500 kv. to 3 mev. has proved most "practical." This range also conforms to the range of supervoltage therapy with gamma-ray beams from radioactive sources, since gamma-ray energies from radioactive isotopes exist only up to about 3 mev.

It may be said, in general, that there are several definite physical advantages of supervoltage roentgen therapy over deep roentgen therapy with 200 kv. First, due to the greater penetration of the rays, there is a corresponding increase in the percentage depth dose, permitting the administration of a larger tumor dose with a simpler technique. However, with the above specified voltages the percentage depth dose, except for a few millimeters below the skin, will continue to remain at all levels smaller than the surface dose, following broadly the pattern of decrease observed in deep roentgen therapy and contrary to what is observed in megavoltage roentgen therapy. Second, the attenuation of the beam within the tissues is less steep, making possible a more homogeneous irradiation especially when smaller fields are used. Third, and this perhaps is the greatest advantage, there is a lesser effect on the skin with supervoltage roentgen therapy as compared with deep roentgen therapy due to the fact that maximum ionization occurs a few millimeters below the skin, the depth very slowly but gradually increasing with the voltage. As a fourth advantage may be added the decreased bone absorption observed with supervoltage roentgen therapy. The implication of these physical advantages in improving the immediate response as well as the long-range results in certain groups of

cancer has now been amply verified.[1,2,3]

Recently, a tremendous impetus has been given to supervoltage radiation therapy by the introduction of apparatus emitting gamma-ray beams of similar energies. These beams are obtained from various artificially produced radioactive sources which are housed in a shielded container of special design operating very much in the same manner as do ordinary roentgen-ray tubes. Brucer[4] and Aebersold[5] who have made important contributions to the study of the medical usefulness of many radioactive materials believe that there are at least six isotopes suitable for practical gamma-ray beam therapy: cobalt (Co^{60}), iridium (Ir^{192}), cesium (Cs^{137}), europium ($Eu^{152-154}$), tantalum (Ta^{182}) and cerium (Ce^{144}). Of these, cobalt 60, iridium 192 and cesium 137 have created the greatest interest. Cobalt 60, which at the present is the best available source, has been used since 1951 in an increasing number of units. These units are of three types and may be called decacurie, hectocurie and kilocurie units, depending on the magnitude of the radioactivity of the cobalt sources housed within them. Cobalt 60 has a half-life of 5.3 years and emits gamma rays of 1.17 and 1.33 mev. energies in equal ratio, which makes it particularly desirable for supervoltage beam therapy.

The decacurie units originated mostly in Europe when several investigators[6,7] employed cobalt 60 sources to replace the radium sources, usually of 5 to 10 grams, in their beam therapy units used for short distances. Since a 10 gram radium source is approximately equivalent in its radioactivity to a 6 curie cobalt 60 source, a definite increase in the relative intensity of the beam is obtained. Emery[8] recently described such a unit in which the 10 gram radium source was replaced with a 6 curie, then a 30 curie and finally a 60 curie cobalt 60 source, the beam now having the equivalent strength of that emitted by 100 grams of radium. The amount of cobalt 60 which could be used for replacement was limited by the protection afforded by the unit itself and by the walls of the treatment room. Of course, this type of unit is suitable only for treatment of lesions situated on the surface or near the surface of the body, the distance from the skin to the cobalt 60 source varying between 5 and 20 centimeters.

The hectocurie units were introduced very recently.[9] They usually contain cobalt 60 sources of 300 to 600 curie strength and are designed for the treatment of medium-deep lesions. The distance at which treatment is given varies from 25 to 40 centimeters.

The kilocurie units, housing cobalt 60 sources of 1,000 curies or more, emit gamma-ray beams of intensities comparable to those of the roentgen-ray beams of electrically operated apparatus. Therefore, they permit treatment of deep-seated lesions at skin-source distances customarily employed in supervoltage roentgen therapy with the use of similar techniques. Since the first such unit was installed by Johns[10] and his associates at the University of Saskatchewan, Saskatoon, in August, 1951, an increasing number of similar installations made their appearance in a short period of time, testifying to the aforementioned advantages of supervoltage radiation therapy

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over deep roentgen therapy, whether given with roentgen-ray or gamma-ray beams.

Iridium 192 has been successfully used since May, 1950, in decacurie units,[11,12] treatment being given at skin-source distances of 8 to 12 centimeters. The quality of the gamma-ray beam emitted by this isotope corresponds to that of a roentgen-ray beam produced by an 800 kv. apparatus. Its disadvantage is that it has a half-life of only seventy days, necessitating a change of the source every month.

Cesium 137 promises to become a most desirable radiation source for teletherapy units in the near future.[9,13] Its attractive properties are the long half-life of thirty-three years, its availability in large quantities and the fact that it emits a gamma-ray beam of 660 kv. energy, necessitating less protection. Because of the rather low specific activity of cesium 137, however, there must be more material in a given source and the unit, therefore, must contain a larger radiation source. A 10 kilocurie unit, provided with mechanisms for a great variety of movements, is now being assembled and tested by the Medical Division of the Oak Ridge Institute of Nuclear Studies.[9]

The introduction in rapid succession of these new apparatus of different energies and intensities has created some understandable confusion in the vocabulary of the clinical radiotherapist, a fact which is amply reflected in the present-day literature. It has been the custom for many years to use the term of "teletherapy" in conjunction with radium treatment to designate that the radium is not employed in the form of surface molds, interstitial needles or intracavitary tubes directly in contact with the lesion, but as a gamma-ray emitting source at a certain distance away from the lesion. Because of the scanty supply of radium, these sources had to be small, usually below the decacurie range, and therefore treatment had to be given at very short distances. With the advent of the above enumerated isotopes, this situation has changed. Perhaps it may not appear out of place at this stage to reconsider the original meaning attributed to the term "teletherapy" and to introduce for clinical use other terms, expressing more appropriately the types of treatment employed. Thus the term of "plesiotherapy" is suggested for treatment with any source at a distance of less than 20 cm., usually requiring decacurie units, since the irradiation is carried out "near" the source. The term of "brachytherapy" or "short" distance therapy could be used for treatment at distances of from 25 to 40 cm., for which the hectocurie units seem to appear most suitable. In this manner the name "teletherapy" could be reserved for treatment at "long" distances of from 60 to 100 cm., as practiced with the kilocurie units. Such a redefinition would also serve to place the gamma-ray "teletherapy" more in accord with the supervoltage roentgen therapy given with electrically operated apparatus. Finally, despite the variation in the specific activity of the different radioactive sources, it would permit irradiation with dose rates of 20 to 40 r per minute which could be obtained with the three types of units at the stated distances.

There can be no doubt that supervoltage radiation therapy, whether carried out with roentgen-ray beams of electrically operated apparatus or with gamma-ray beams of various radioactive sources, will continue to increase in popularity in the future, and therefore the aforementioned suggestions might prove of practical value.

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LEWIS GREGORY COLE
1874-1954

THE death of Lewis Gregory Cole in October, 1954, in his eighty-first year removes from the earthly scene another pioneer in American roentgenology. He is rightly assigned to that select group which laid the foundations of radiology in this country, although his important work was begun at a somewhat later date than that of the earliest pioneers, among whom were Caldwell, Dodd, Hickey, Leonard, Pfahler, and Williams.

The contribution to roentgenology for

which Lewis Gregory Cole will be remembered was his work on duodenal ulcer. No one who had the privilege of seeing him at work in his early years will forget the painstaking care with which he examined a patient for ulcer. The accurate location of the duodenal bulb by means of his mirror fluoroscope mounted in the "Cole" table, the making of literally scores of "spot" roentgenograms of a single patient, the time-consuming matching of the duodenal silhouettes, and the confidence with which he finally stated his conclusions, was a demonstration which left no doubt that duodenal ulcer could be diagnosed by means of the roentgen ray. The difficulties which he overcame are better understood if one recalls that Cole was working with the old, fickle gas tube and with glass plates instead of films, and that his work was done long before the time of automatic plate-changers and the Potter-Bucky grid. The fact that fluoroscopy and modern spot films have long replaced Cole's method does not detract in the least from the importance of his original work in this field.

This is not the place to make a list of Dr. Cole's many contributions to roentgenology but it should be recorded that among them was his recommendation when the United States entered the First World War that a chest plate should be made of every person inducted into the Armed Services. The present writer, who was in charge of the radiological division of the United States Army in that war, has vivid recollections of numerous encounters with Dr. Cole as he insisted in a vehement manner characteristic of him upon the desirability and even the necessity of x-raying the chest of everyone entering the military services. He had the vision to see the many advantages which time has proven of such an examination, and it was not his fault that it was not until the Second World War that his recommendations became effective.

Lewis Gregory Cole, throughout his entire career, was a man of strong convictions for which he would contend in private conversation and in public debate, often with evangelistic fervor. Even those who disagreed with him never doubted his sincerity or his integrity of character. It was characteristic of him that he retained his courage and enthusiasm and a strong faith even through a long, last illness, and after the death of a beloved wife which followed their golden anniversary. It seems very fitting, too, that his last work was an autobiography which he entitled "Fifty Fighting Years." It is our hope that his work was sufficiently advanced to warrant its publication. He holds a unique place in American radiology and will be remembered and missed as long as any survive who came under his stimulating influence.

ARTHUR C. CHRISTIE, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Palmer House, Chicago, Ill., Sept. 20–23, 1955.

American Radium Society
Secretary, Dr. R. E. Fricke, Mayo Clinic, Rochester, Minn. Annual meeting: Shoreham Hotel, Washington, D. C., April 21–23, 1955.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: Biltmore Hotel, Los Angeles, Calif., Dec. 5–10, 1954.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois. Annual meeting: Drake Hotel, Chicago, Ill., Feb. 9–12, 1955.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich.

Fifth Inter-American Congress of Radiology
Secretary-General, Dr. Eugene P. Pendergrass, 3400 Spruce St., Philadelphia 4, Pa. Meets at Shoreham Hotel, Washington, D. C., April 24–29, 1955.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. J. A. Norton, 843 Donaghey Bldg., Little Rock, Ark. Meets every three months and also at time and place of State Medical Association.

Atlanta Radiological Society
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Clayton G. Weig, 135 Linwood Ave., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

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Central Ohio Radiological Society
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Connecticut Valley Radiologic Society
Secretary, Dr. B. B. Alicandri, 20 Maple St., Springfield, Mass. Meets second Friday October and April.

Dallas-Fort Worth Radiological Club
Secretary, Dr. O. H. Grunow, 650 Fifth Ave., Fort Worth, Texas. Meets monthly, third Monday, at Greater Fort Worth International Airport at 6:30 P.M.

Detroit Roentgen Ray and Radium Society
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East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. J. T. Shelden, Box 1021, Lakeland, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
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Greater Miami Radiological Society
Secretary, Dr. R. D. Shapiro, 541 Lincoln Rd., Miami Beach, Fla. Meets monthly at various South Florida Hospitals.

Houston Radiological Society
Secretary, Dr. Harry Fishbein, 324 Medical Arts Bldg., Houston 2, Texas. Meets fourth Monday each month at Hermann Hospital.

Idaho State Radiological Society
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

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Kings County Radiological Society
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* Secretaries of societies are requested to send timely information promptly to the Editor.

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Secretary, Dr. John R. Hodgson, Mayo Clinic, Rochester, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

MISSISSIPPI RADIOLOGICAL SOCIETY
Secretary, Dr. John W. Evans, 117 N. President St., Jackson, Miss. Meets third Thursday of each month at Hotel Edwards, Jackson, at 6:00 P.M.

MONTANA RADIOLOGICAL SOCIETY
Secretary, Dr. Grant P. Raitt, Suite 413 Medical Arts Bldg., Billings, Montana. Meets at least once a year.

NASSAU RADIOLOGICAL SOCIETY
Secretary, Dr. Alan E. Baum, Hicksville, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. J. F. Kelly, Jr., 816 Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets third Friday of each month, October through May, at Hotel Commander, Cambridge, Mass.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Sidney Rubenfeld, 477 First Ave., New York 16, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Sternbergh, Charlotte Memorial Hospital, Charlotte, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Marianne Wallis, St. Joseph's Hospital, Minot, N. Dak. Meetings by announcement.

NORTH FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. Ivan Isaacs, 1645 San Marco Blvd., Jacksonville, Florida. Meets quarterly in March, June, September and December.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY
Secretary, Dr. D. H. Baxter, Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY
Secretary, Dr. H. B. Stewart, 2920 Capitol Ave., Sacramento, Calif. Meets at dinner last Monday of each month, September to June.

OHIO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. M. M. Thompson, Jr., 319 Toledo Medical Bldg., Toledo 2, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY
Secretary, Dr. F. C. Shipps, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets annually in May.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Next annual meeting at Berkshire Hotel, Reading, Penna., May 20 and 21, 1955.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. H. M. Stauffer, Temple University Hospital, Philadelphia 40, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. Donald H. Rice, Western Pennsylvania Hospital, Pittsburgh 24, Pa. Meets second Wednesday of month, October through June at Hotel Roosevelt.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. William A. Goodrich, 85 Jefferson St., Hartford 6, Conn. Meetings are held bi-monthly.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF GREATER CINCINNATI
Secretary, Dr. Wm. R. Dickens, Cincinnati General Hospital, Cincinnati 29, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

RADIOLOGICAL SOCIETY OF HAWAII
Secretary, Dr. H. C. Chang, 1282 Emma St., Honolulu 13, T. H. Meets third Monday evening of each month at designated hospitals.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA
Secretary, Dr. J. T. Brierre, 700 Audubon Bldg., New Orleans. Meets annually during Louisiana State Medical Society Meeting.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. Carye-Belle Henle, 195 North 7th St., Newark, N. J. Meets at Atlantic City at time of State Medical Society and in November in Newark, N. J.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA
Secretary, Dr. George Jacobson, 1200 N. State St., Los Angeles 33, Calif.

RICHMOND COUNTY RADIOLOGICAL SOCIETY
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga. Meets first Thursday of each month at various hospitals.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Henry H. Forsyth, Jr., 40 Meigs St., Rochester, N. Y. Meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY
Secretary, Dr. John H. Freed, 4200 East Ninth St., Denver 7, Colo.

St. Louis Society of Radiologists
Secretary, Dr. W. B. Seaman, 510 South Kingshighway, St. Louis 10, Mo. Meets fourth Wednesday each month, except June, July, August and September.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brook Army Medical Center Officers Mess first Monday of each month.

San Diego Radiological Society
Secretary, Dr. C. W. Bruner, 2456 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. T. M. Fullenlove, 110 El Verano Way, San Francisco 27, Calif. Meets quarterly at Grison's Steak House.

Section on Radiology, California Medical Association
Secretary, Dr. H. R. Morris, 1027 "D" St., San Bernardino, Calif.

Section on Radiology, Medical Society of the District of Columbia
Secretary, Dr. John A. Long, 1801 K St., N.W., Washington 6, D. C. Meets Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M. September to May inclusive.

South Bay Radiological Society
Secretary, Dr. H. R. Berman, 309 St. Claire Bldg., San Jose, Calif. Meets second Wednesday of each month.

South Carolina Radiological Society
Secretary, Dr. William A. Klauber, Self Memorial Hospital, Greenwood, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. G. K. Henshall, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Houston, Texas, January 21 and 22, 1955.

Tri-State Radiological Society
Secretary, Dr. S. N. Tager, 219 Walnut St., Evansville, Ind. Meets last Wednesday of Oct., Jan., March and May, 8:00 P.M. at Elks' Club in Evansville.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets fourth Wednesday in January, March, May, September and November at Holy Cross Hospital.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Eva L. Gilbertson, 1317 Marion St., Seattle 4, Wash. Meets fourth Monday of each month from September through May at 610 Pine St., Seattle.

West Virginia Radiological Society
Secretary, Dr. W. Paul Elkin, 515 Medical Arts Bldg., Charleston, W. Va. Meets concurrently with annual meeting of West Virginia State Medical Society; other meetings arranged by program committee.

Westchester Radiological Society
Secretary, Dr. M. G. Priestman, New Rochelle Hospital, New Rochelle, N. Y. Meets on third Tuesday of January and October and on two other dates.

Wisconsin Radiological Society
Secretary, Dr. W. W. Moir, 309 Geele Ave., Sheboygan, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. Wm. W. Saunders, Veterans Administration Hospital, San Francisco 21, Calif. Meets monthly, third Thursday, at 7:45 P.M., Lane Hall, Stanford University Hospital.

Cuba, Mexico, Puerto Rico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiología, A. C.
Secretary General, Dr. Eugenio Toussaint, Calle del Oro No. 15, Mexico 7, D.F. Meets first Monday of each month.

Asociación Puertorriqueña de Radiología
Secretary, Dr. Rafael A. Blanes, Ave. Ponce de Leon 1175, Santurce, P. R.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

Association of Radiologists of the Province of Quebec
Secretary, Dr. Jean-Louis Léger, 1560 Sherbrooke St., Montreal, Que. Meets four times a year.

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Candian Association of Radiologists
Honorary Secretary-Treasurer, Dr. D. L. McRae, Suite 305, 1555 Summerhill Avenue, Montreal 25, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electro-Radiologie Médicales
General Secretary, Dr. Ls Ivan Vallée, 1058 rue St-Denis, Montreal 18, Canada. Meets third Saturday each month.

College of Radiologists (Australia and New Zealand)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral. Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly sec-

ond Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL SUR, SEDE, LA PLATA
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL CENTRO SEDE, CORDOBA
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL NORTE, SEDE, TUCUMAN
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DE CUYO SEDE, MENDOZA.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

SOCIEDADE BRASILEIRA DE RADIOLOGIA MEDICA
Secretary, Dr. Nicola Caminha, Av. Mem. de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

SOCIEDADE BRASILEIRA DE RADIOTERAPIA
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

SOCIEDAD COLOMBIANA DE RADIOLOGIA
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6° piso, Bogota, Colombia. Meets last Thursday of each month.

SOCIEDAD PERUANA DE RADIOLOGIA
Secretary General, Dr. Amador Holgado V., Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

CONTINENTAL EUROPE

SOCIÉTÉ BELGE DE RADIOLOGIE
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

SOCIÉTÉ FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALE, and its branches: SOCIÉTÉ DU SUD-OUEST, DU LITTORAL MÉDITERRANÉEN, DU CENTRE ET DU LYONNAIS, DE L'OUEST, DE L'EST, ET D'ALGER ET D'AFRIQUE DU NORD
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX°, France.

CESKOSLOVENSK SPOLEČNOST PRO RËNTGENOLOGII A RADIOLOGII V PRAZE
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

DEUTSCHE RÖNTGEN-GESELLSCHAFT
Secretary, Dr. med. Peter Kröker, Evangelisches Krankenhaus, Huyssens Stiftung, (22a) Essen.

SOCIETA ITALIANA DI RADIOLOGIA MEDICA
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

NEDERLANDSE VERENIGING VOOR ELECTROLOGIE EN ROENTGENOLOGIE
Secretary, Dr. B. J. Rethmeier, Bornsestraat 378, Almelo, Netherlands.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

GDANSK SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept., Akademia Gdansk.

WROCLAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. R. Marciniak, Akad. Medyczna Wroclaw, 68 Curie-Sklodowska St., Wroclaw, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wroclaw.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S.I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT (SOCIÉTÉ-SUISSE DE RADIOLOGIE)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

INDIA

INDIAN RADIOLOGICAL ASSOCIATION
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

ANNOUNCEMENT OF NEW PUBLICATIONS

NATIONAL BUREAU OF STANDARDS

Three important new publications have recently been issued by the National Bureau of Standards.

Protection against Radiations from Radium, Cobalt-60, and Cesium-137. National Bureau of Standards Handbook 54, 60 pages, price 25 cents.

The increased applications of radium sources and the changes in the maximum permissible dose have made necessary a revision of the radium protection code of the National Committee on Radiation Protection, National Bureau of Standards Handbook 23. Furthermore, the nuclear reactor has produced other high energy, relatively long-lived, gamma emitters that are being used or may be used for similar applications. At the same time, radon plants have become rare.

The enlarged scope of the present Handbook thus deals with protection against radium, cobalt-60, and cesium-137. However, the general principles outlined for these sources will also be applicable to other gamma emitters as they become available and attenuation data are obtained for them. No specific references are made to industrial applications, since these are to be treated in a separate code; however, the basic principles and the attenuation data of this Handbook are applicable to both medical and industrial uses.

The recommendations contained in Handbook 54 represent what are believed to be the best available opinions on the subject as of this date. This Handbook was prepared by the Subcommittee on Protection against Radiations from Radium, Cobalt-60, and Cesium-137 Encapsulated Sources.

Radioactive-Waste Disposal in the Ocean. National Bureau of Standards Handbook 58, 31 pages, price 20 cents.

The ever increasing production and use of radioactive isotopes has raised numerous questions concerning their handling, transportation, and ultimate disposal. It appears that the sea may be an appropriate place for the disposal of intermediate and large amounts of isotopes having long half-lives (more than one year) or high radiotoxicity. It is the purpose of this Handbook to bring to the attention of those concerned, the many different factors that should be taken into account when radioactive wastes are to be dumped into the ocean, and to make recommendations for the proper use of this disposal method. The recommendations contained in Handbook 58 represent what are believed to be the best available opinions on the subject as of this date. This Handbook was prepared by the Subcommittee on Waste Disposal and Decontamination of the National Committee on Radiation Protection.

Permissible Dose from External Sources of Ionizing Radiation. National Bureau of Standards Handbook 59, 79 pages, price 30 cents.

The recommendations and discussions of permissible dose contained in this Handbook form the basis of all other recommendations of the the National Committee on Radiation Protection, including permissible doses for radioactive material within the body, safe handling of radioactive materials, waste disposal, etc. Although the formal preparation of this report has been delayed for a considerable time, the substance of the recommendations of the Subcommittee on Permissible Dose from External Sources has been well known and in use for a number of years.

This Handbook presents discussions of the basic concepts of permissible dose and discussions of each of the many factors considered in the formulation of the recommendations. For easy reference the limits of exposure of various parts of the body to various types of ionizing radiation are briefly stated in the section "Protection Rules."

At the meeting of the International Commission on Radiological Protection in Copenhagen in 1953 this report was used as a basis for the discussion, and the general principles developed by this subcommittee were included in the most recent international recommendations.

These Handbooks may be ordered from the Government Printing Office, Washington, 25 D. C. Foreign remittances must be in U. S. exchange and should include an additional one-third of the publication price to cover mailing costs.

COURSE ON CLINICAL USE OF RADIOACTIVE ISOTOPES

A course on the clinical use of radioactive isotopes will be given by Dr. S. Feitelberg and Dr. Edith H. Quimby of the Department of Radiology, Columbia University, New York City. The dates of the course are May 30 through June 24, 1955, Monday through Fri-

day, 9–12 a.m. and 1–5 p.m. The fee is $200.00 for the course.

This is a full-time course which includes lectures, clinical rounds, experimental laboratory exercises as well as clinical laboratory measurements on patients and on specimens. In addition to the listed instructors, sixteen invited lecturers from the New York area will present topics in their special field.

Lectures. Physics of radioactive isotopes and of interaction of radiation and matter. Techniques and measurements of radiation and of radioactive isotopes. Clinical use of radioactive iodine in thyroid disease. Therapeutic use of radioactive phosphorus and radioactive gold. Diagnostic use of miscellaneous isotopes (determination of blood volume, localization of brain tumors, radioactive sodium and radioactive iron). Organization of radioisotope work in a hospital.

Laboratory Work. Thirteen afternoon sessions devoted to experiments on basic methods of radioisotope measurements, on techniques used in clinical diagnostic work and experience with equipment actually used in clinical procedures.

Maximum class, twelve.

FELLOWSHIP AT THE REGISTRY OF RADIOLOGIC PATHOLOGY

The American Roentgen Ray Society, the American College of Radiology, and the Radiological Society of North America, at the Armed Forces Institute of Pathology, Washington, D. C., offers an appointment for study and correlation of the voluminous roentgenologic and pathologic material at the Institute under the supervision of skilled pathologists and well known teachers of clinical radiology who act as visiting consultants.

Appointments begin on October 1, January 1, April 1, and July 1, all for a period of six months each, carry a stipend of $250.00 per month.

Applicants for this appointment must have completed a minimum of two years of training in an approved Residency in Radiology, preferably with six months of pathology. Under certain circumstances, the latter requirement may be waived. Preference will be given to applicants who have completed an approved residency in Radiology or are eligible for the American Board of Radiology examination.

For further information apply to Aubrey O. Hampton, M.D., Secretary, Inter-Society Committee for the Registry of Radiological Pathology, Garfield Memorial Hospital, Washington, D. C.

FELLOWSHIPS IN RADIOLOGICAL PHYSICS AND INDUSTRIAL HYGIENE

Applications for U. S. Atomic Energy Commission Fellowships in Radiological Physics and Industrial Hygiene for the 1955–1956 school year are now being received by the Oak Ridge Institute of Nuclear Studies.

The two fellowship programs have taken on increased industrial participation in the atomic energy program and the impending development of power reactors for the generation of electricity and for propulsion purposes.

The Industrial Hygiene Fellowship Program supports individuals who are studying for the master's degree in this field at either the Harvard University School of Public Health or the University of Pittsburgh Graduate School of Public Health.

Radiological physics fellowships are carried out in three separate programs as follows: At Vanderbilt University and Oak Ridge National Laboratory, at the University of Rochester and Brookhaven National Laboratory, and at the University of Washington and the Hanford Works. In each case, nine months of course work at the university is followed by three months of additional study and field training at the cooperating Atomic Energy Commission installation. Up to 25 fellows may be appointed in each of the three programs, and course work may be applied toward an advanced degree. Six month extensions may be granted in some cases for completion of work on the master's degree.

Basic stipend for both fellowships is $1,600.00 with an allowance of $350.00 for a spouse and $350.00 for each dependent child. Tuition and laboratory fees are paid as a part of the fellowship. Industrial hygiene fellows may receive an additional allowance of $200.00 if they have already completed a year of graduate study or have appropriate work experience.

The Atomic Energy Commission supports the two fellowship programs to help meet the critical personnel shortage in these fields.

Application forms and additional information may be obtained from the Fellowship Office, University Relations Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee.

WILLIAM OSLER MEDAL

The American Association of the History of Medicine announces its annual competition for the William Osler Medal. This contest is open to the undergraduates of American and Canadian medical schools. Essays should not exceed 10,000 words in length and should be sent to the Committee Chairman, Dr. Lloyd G. Stevenson, 3640 University Street, Montreal, Canada, before March 1, 1955.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA

The next meeting of the Radiological Society of Southern California will be held at the Beverly Hills Hotel, Beverly Hills, California, on Saturday, January 22, 1955. The meeting will start at 2 p.m. and the guest speaker will be Dr. Maurice Lenz of New York. Additional information may be had from the Program Chairman, Dr. Robert B. Engle, St. Luke Hospital, Pasadena, 8 Calif.

AMERICAN COLLEGE OF RADIOLOGY

The annual meeting of the American College of Radiology will be held in Chicago at the Drake Hotel, February 9–12, 1955. The Board of Chancellors will meet Wednesday and Thursday, February 9–10. On Friday, February 11, the annual meeting and banquet, preceded by the College convocation, will be held.

The 22nd Annual Conference of Teachers of Clinical Radiology will be held on Saturday, February 12, 1955.

MID-WINTER RADIOLOGICAL CONFERENCE

The Seventh Annual Mid-Winter Radiological Conference, sponsored by the Los Angeles Radiological Society, will be held at the Ambassador Hotel in Los Angeles, California, on Saturday and Sunday, February 26 and 27. 1955.

The following speakers will present papers on the subjects listed:

Prof. Olle Olsson, Lund, Sweden
1. Renal Angiography
2. Tolerance to Contrast Media

Paul C. Hodges, M.D., Chicago, Illinois
1. Neoplasms of Bone
2. Fibrous Dysplasia of Bone

Simeon Cantril, M.D., Seattle, Washington
1. Hodgkin's Disease
2. Palliation and Care of Terminal Patients

Leslie Bennett, M.D., Los Angeles, California
1. Medical Isotopes

George Jacobson, M.D., Los Angeles, California
1. Value of PA Chest Film in Cardiac Radiology

Ross Golden, M.D., Los Angeles, California
1. Tumors of the Small Intestine
2. Physical Problems in Detection of Cancer of the Stomach

Charles E. Grayson, M.D., Sacramento, California
1. The Pulmonary Cripple

Informal round table luncheons with the guest speakers will be featured both days with the cost of the luncheons included in the Conference fee of $20.00. An additional charge of $6.50 per person will be made for the banquet on Saturday evening February 26. Residents in radiology and radiologists in active military service will be admitted to the scientific sessions of the conference without payment of registration fee.

Conference reservations may be made through the chairman, Richard A. Kredel, M.D., 65 North Madison Avenue, Pasadena, California. Please make checks payable to Mid-Winter Radiological Conference.

Hotel reservations should be made as soon as possible through the Convention Manager of the Ambassador Hotel.

THIRD EUROPEAN RHEUMATOLOGY CONGRESS

The Third European Rheumatology Congress will be organized by the "Nederlandse Vereniging van Rheumatologen" and will be held from June 13 to June 17, 1955, at Scheveningen, The Hague, Netherlands, under the auspices of the Ligue Européenne contre le Rhumatisme.

Information concerning the Congress may be obtained from the Secretary of the Congress, Dr. H. van Swaay, Pieter Bothstraat 12, The Hague, Netherlands.

MISSISSIPPI RADIOLOGICAL SOCIETY

The present officers of the Mississippi Radiological Society are as follows: *President*, Dr. Albert J. McIlwain; *Vice-President*, Dr. John W. Evans; *Secretary-Treasurer*, Dr. James M. Packer, 621 High St., Jackson, Mississippi. The Society continues to meet monthly on the third Thursday, at 6:00 P.M. The meeting place has been changed to Hotel Edwards, Jackson, Mississippi.

NORTH DAKOTA RADIOLOGICAL SOCIETY

At a meeting of the North Dakota Radiological Society held in Grand Forks on May 3, 1954, the following new officers were elected: *President*, Dr. Phil Berger, Grand Forks, North Dakota; *Vice President*, Dr. Johann Eriksen, Bismarck, North Dakota; *Secretary*, Dr. Marianne Wallis, St. Joseph's Hospital, Minot, North Dakota; *Treasurer*, Dr. H. M. Berg, Bismarck, North Dakota.

SAN FRANCISCO RADIOLOGICAL SOCIETY

The San Francisco Radiological Society at its last meeting elected the following officers for the year 1954–1955: *President*, Dr. Charles S. Capp; *President-Elect*, Dr. Ivan J. Miller; *Secretary-Treasurer*, Dr. Tom M. Fullenlove, 110 El Verano Way, San Francisco 27, California.

SOCIEDAD PERUANA DE RADIOLOGIA

The following are the recently elected officers of the Peruvian Radiological Society for the year 1954–1955: *President*, Dr. Vicente Ubillús; *Vice President*, Dr. Jorge de la Flor V.; *Secretary General*, Dr. Amador Holgado V., Apartado, 2306; *2nd Secretary*, José Luis Becerra; *Treasurer*, Napoleón Mattos.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return or the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

MAN'S BACK. By Theodore A. Willis, M.D., F.A.C.S., Formerly Head, Department of Orthopedic Surgery, St. Luke's Hospital; Consulting Orthopedic Surgeon, U.S.P.H.S. Hospital, Cleveland, Ohio; Member American Orthopedic Association; The American Academy of Orthopedic Surgeons; The Clinical Orthopedic Society; Société Internationale de Chirugie Orthopedique et de Traumatologie. Cloth. Price, $9.50. Pp. 170, with 210 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

This monograph discusses from a practical point of view the present status of our knowledge of the difficult problem of back pain. The author, in his preface, draws attention to the fact that perfection of the roentgen ray and the technique of its use, and increased knowledge of physiology and biochemistry, have resulted in a renewed interest in the causation of back pain. Various theories of its cause and various methods of treatment have been suggested and tried. The author states that the physician has learned to treat not back ache but the patient with the aching back. He has had a vast personal experience. He presents his views in the monograph based on this experience and has attempted to cull from the multiplicity of theories, methods of treatment and operations, and newer discoveries relative to back pain, those of actual and tried value. In this he has succeeded and the reader finds much useful knowledge. He has made no pretense of tracing materials for the monograph back to their original sources. Quoting again from the preface, he has enjoyed expressing personal opinions based upon his own experience, without subjecting himself or his assistants to a search of medical literature to determine the sources from which these opinions were derived. In consequence, the monograph lacks a bibliography.

The book contains chapters on the embryology and the anatomy of the back, vertebral anomalies and defects of development, the mechanics, the examination of the patient, injuries, diseases, tumors of the back, scoliosis, psychoneuroses and malingering, physical therapy of back lesions and operations on the back. This list illustrates the comprehensive view of the subject.

Throughout the book conservative treatment is recommended but, as in the case of congenital elevation of the scapula (Sprengel's deformity), where conservative treatment is of no avail, operation is recommended as of definite value. The operations described are those for excision of pathologic tissues, relief of compressions, stabilization of inadequate mechanisms, and correction of anatomical faults.

The monograph is of limited size and this precludes extensive discussion of some sections, such as for instance, that of tumors of the back, especially those of the vertebrae. The chapters on psychoneuroses and malingering reflect the author's experience and contain much useful information and advice. Likewise special mention can be made of those on the mechanics of the back and the physical examination of the patient.

The format of the book is excellent and the style is very readable and clear. Roentgenograms of many of the conditions are included. This book can be well recommended and should be of great interest and benefit to all physicians interested in the treatment of the aching back.

RALPH S. BROMER, M.D.

FUNDAMENTALS OF CLINICAL ORTHOPEDICS. By Peter A. Casagrande, M.D., Orthopedic Department of Buffalo General Hospital, Buffalo Children's Hospital, and the University of Buffalo Medical School; Attending Orthopedist at the Chronic Disease Research Institute of the University of Buffalo, and the Veterans Administration Hospital, Buffalo, New York; and Harold M. Frost, Jr., M.D., Orthopedic Department of Buffalo General Hospital and the University of Buffalo Medical School, Buffalo, New York. Cloth. Price, $18.50. Pp. 582, with numerous illustrations. Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, New York, 1953.

This book represents the work of 13 special

and 35 additional contributors in 8 sections and 35 chapters, some of which are quite heterogeneous.

The book attempts to collect for ready reference the basic sciences of physiology, chemistry, pathology and anatomy, all so important in rational understanding and treatment of disease and injury. This it accomplishes to considerable degree, but the authors themselves at times fail to resort to the fundamentals which they urge. Thus in Section II on congenital affections, opportune references to their embryological and phylogenetic etiology are lacking.

Undeniably, contemporary orthopedic interest is directed more toward technical operations than toward the fundamental disturbances that result in the operable lesions. For example, a hip prosthesis is introduced and the patient discharged with no attention to the degenerative disease that made the operation necessary. The authors discuss this hip condition clinically under the head of osteo-arthritis in Chapter 11. Here again the word heterogeneous comes to mind as it does repeatedly throughout the book due to repetitious and conglomerate discussions.

The book tends to go beyond its titled scope and become a treatise on Orthopedic Surgery. As such it is well worth while, though readers probably will differ occasionally with the authors' opinions. It is well printed, well illustrated and well indexed, and should remind orthopedists and other surgeons to treat patients rather than diseases and injuries.

Theodore A. Willis, M.D.

Building America's Health. America's Health Status, Needs and Resources—Volume 2, and Volume 3. By The President's Commission on the Health Needs of the Nation. Paper. Volume 2, price $1.25; Volume 3, price $1.50. Pp. 320 and 299. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1953.

Recently, the findings and recommendations of the President's Commission, appointed in 1951, on the Health Needs of the Nation, have been reported in five volumes, as follows: Volume 1, Findings and Recommendations; Volumes 2 and 3, America's Health Status, Needs and Resources; Volume 4, Financing a Health Program for America; Volume 5, The People Speak, Excerpts from Regional Public Hearings on Health.

No attempt will be made to present an all inclusive review of the contents of Volumes 2 and 3 which were the ones available to the reviewer for evaluation. Needless to say, one is somewhat bewildered with the huge amount of information which has been collected and presented, along with certain specific recommendations, by a committee headed by Dr. Paul B. Magnuson, Professor Emeritus and Former Chairman, Department of Bone and Joint Surgery, Northwestern Medical School, Chicago, Illinois.

The Commission reports that principal needs in the United States to achieve progress in the promotion of health are as follows: (1) Education of health personnel in a broader approach to the care of the individual with more training especially in the fields of nutrition and mental health; education of key persons for leadership who work with health and social agencies and community groups; better education of the public in health matters. (2) A study of the needs and resources in local areas. (3) Improving health and medical services for all the people. (4) Development of adequate social measures for control of health factors in the environment. (5) A study of the social and physical factors which affect physical and mental health; research in the physiologic processes of life from birth to old age; a study of accident prevention; an investigation of the doctor-patient relationship; an evaluation of the status of the physician in rural areas; and a determination of the attitude of the people toward different methods of providing medical care. (6) Community organization.

Although the reviewer cannot agree with all the conclusions or recommendations made by the committee, he must extend to them his congratulations for having collected a large amount of valuable and pertinent information which clarifies some of the problems to be solved. All persons who take the time to read these publications will have a much better knowledge of the problems of health in this country. Even if he does not agree with the conclusions of the committee, it must be acknowledged that they are provocative and thought-stimulating.

Cyrus C. Sturgis, M.D.

Advances in Cancer Research. Volume I. Edited by Jesse P. Greenstein, National Cancer Institute, U. S. Public Health Service, Bethesda, Maryland; and Alexander Haddow, Chester Beatty Research Institute,

Royal Cancer Hospital, London, England. Cloth. Price, $12.00. Pp. 590. Academic Press Inc., Publishers, 125 East 23rd Street, New York 10, New York, 1953.

Edited jointly by a noted British scientist and a noted American scientist this volume presents a series of chapters covering different aspects of cancer research. The present volume constitutes an up-to-date presentation of the status of various aspects of investigation, from carcinogenesis to the role of nutrition and the utilization of radioisotopes in cancer research.

According to Coulson, the original view that the electric charge of the K-region was alone significant in the carcinogenesis of polycyclic molecules, has now been replaced by the admission that the K-region data may only represent one of the various stages in the completion of the phenomenon of carcinogenesis. Cowdry makes interesting comparisons of the epidermis of mice and of men; he observes that the spinous cells are more profoundly modified by carcinogens than the cells of the granular and basal layers; Cowdry believes that the data at hand are consistent with the theory that malignant transformation is due to one of several mutations. Dmochowski presents an able summary of the knowledge of the milk agent and mammary tumors. It is now generally acknowledged that both the production and response of mammary tissues to the milk agent, and the consequent development of cancer of the breast are controlled by genetic factors. Age seems to play a role since mature mice of susceptible strains are less responsive to the milk agent than the young ones; this decreased qualitative response can be overcome, in the cancer susceptible mature mice, by the exposure to larger quantities of the agent, but larger quantities are not effective on the nonsusceptible strains. The induction of breast cancer by hormones is dependent on the susceptibility of the mice and on the presence of the milk agent. The induction of breast cancer by means of carcinogenic hydrocarbons is governed by a different susceptibility than that of the milk agent but it is also influenced by hormones. Gardner discusses hormones in relation to tumorigenesis. It is not known whether the hormone itself or its metabolic products are actually carcinogenic; hormones may incite the formation of carcinogens quite differently from themselves, merely accelerating their normal appearance with age. The sequence of response is usually as follows: first, growth is produced and maintained, then growth ceases and may actually regress; at this time localized hyperplastic foci appear which at first may be dependent upon special hormone environments but subsequently become autonomous.

Tannenbaum and Silverstone review the subject of nutrition in its relationship to cancer; they feel that a dietary change may influence carcinogenesis by (1) modifying the solubility, rate of metabolism or the amount of carcinogen actually reaching the tissues, (2) by modifying the susceptibility of the cells and (3) by modifying the development of the initiated growth. Harris presents an excellent discussion of the progress made in the field of virus-induced tumors, with special reference to Rous (number one) sarcoma. Heidelberger gives us a view of the possibilities of progress through the use of radioisotopes in the study of metabolism. Miller and Miller write on amino-azo dyes and Ross on the cytotoxic alkalating agents. These comprehensive chapters are all followed by extensive references.

J. A. del Regato, M.D.

Die Nahbestrahlung. Von Henri Chaoul, Früher o. ö. Professor für Röntgenologie an der Universität Berlin; und Felix Wachsmann, Dozent für medizinische Physik an der Universität Erlangen. Cloth. Price DM 39. Pp. 225, with 304 illustrations. Georg Thieme Verlag, Stuttgart, 1953.

About twenty years ago Chaoul introduced his method of contact therapy into radiologic practice. His basic intention was to imitate as closely as possible the rapid drop of intensity which is characteristic of radium contact therapy. This permits the delivery of a high tumor dose at the same time sparing the surrounding and underlying normal tissue.

The text is divided in two main parts: a general and a clinical section. The former covers the physical-biological foundations of contact therapy including a detailed discussion of dosimetry. The authors prefer a potential of 60 kilovolts, inherent filtration of 0.15 to 0.2 mm. Cu equivalent and a focus-skin distance of 1.5, 3 and 5 cm. They feel that the quality of radiation comparing radium and roentgen-ray contact therapy is without biologic significance.

The apparatus, namely generator, types of tubes and required accessories, are described in detail.

In the clinical section the authors relate their experience in the treatment of numerous malignant conditions amenable to contact therapy. Complete data regarding technique of application are given. This includes the use of contact therapy in the treatment of neoplasms of the skin, eye region, lip, oral cavity, nose, throat and larynx, superficial lymph gland metastases, carcinoma of the rectum and others. Its use in the treatment of benign skin conditions is briefly outlined and a little over a page is devoted to a discussion of the use of contact therapy in inflammatory disease. The bibliography contains 695 references!

Many good illustrations are provided; this includes diagrams as well as photographs of clinical material. The paper is excellent.

Every radiologist with a reading knowledge of German who intends to use contact therapy will definitely profit by reading this book.

E. A. POHLE, M.D.

ROENTGEN, RADIUM AND RADIOISOTOPE THERAPY. By A. J. Delario, M.D., Member of the American College of Radiology; American Board of Radiology; Radiological Society of North America; Head of Therapeutic Radiology, St. Joseph Hospital, Paterson, New Jersey. Cloth. Price, $7.50. Pp. 371, with 65 illustrations and 155 tables. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1953.

Many will remember Delario's "Hand Book of Roentgen and Radium Therapy" published in 1938 as a valuable compendium of physical tables and charts widely drawn from the literature into a practical reference book. The author's present book likewise presents selected charts and figures covering the physical characteristics, biological effects and clinical application of roentgen rays, radium and radioisotopes gleaned from the literature of the past fifteen years with supporting bibliography. The treatise is well integrated and might well serve as a supplementary text in radiobiology and radiation physics.

The book begins with a discussion of the nature of radiation, its penetration and absorption, physical factors influencing dosage, the physical, chemical and biological changes produced and the injuries caused by ionizing radiation. The physical characteristics of radium and radium tissue dosage are discussed and supported by tables from Quimby, Paterson and Parker, Martin and others. About seventy pages are devoted to radioisotopes discussing physical characteristics, tissue dosage, diagnostic and therapeutic applications and safe handling. The newer therapeutic modalities, including the cobalt bomb, megavoltage radiation, the betatron, electron therapy and rotational therapy are also discussed. Protection against all types of ionizing radiation is reviewed. The physics of atomic fission, hazards from atomic bomb explosion and protection against these hazards are concisely presented.

The book is well organized, integrated and oriented primarily toward practical applications in the field of radiation therapy. We recommend it to all students and workers interested in the physical aspects of radiation therapy, providing as it does comparative data helpful in the planning of therapy and in the evaluation of potential contributions from megavoltage therapy and radioisotopes.

HOWARD B. HUNT, M.D.

LOS RADIOISOTOPOS EN LA CLINICA. By C. Blanco-Soler, M.D., Chief of the Medical Service, Central Red Cross Hospital, Madrid, Spain, with the collaboration of Drs. J. W. Otte, A. Salgado, I. Madrigal, Blanco-Soler y Bos, Sanchez Serrano and F. Martino Savino and two contributed chapters by Profs. Luis Bru and R. Ortiz-Forraguera. Paper. Pp. 237, with 57 illustrations. Paz Montalvo, Madrid, Spain, 1952.

This book extends beyond the limits of its title; fifty pages are given to two contributed chapters on nuclear physics, also there are lengthy historical references to milestones in the knowledge of the conditions treated and of the therapeutic developments.

In the diagnosis of thyroid diseases with radioiodine, the author finds the rate of thyroid uptake, during a two-hour period to be more reliable than the methods of urinary clearance, etc. In the treatment of hyperthyroidism the only recognized contraindication is the coincidence of pregnancy. About 60 to 75 per cent of cases of hyperthyroidism are reported controlled by a single dose of 3 to 5 microcuries; few may require a second or third application and the total remissions are raised to 80 per cent. With the help of a "microdetector" a study of the accumulation of radiophosphorus may permit the diagnosis of tumors of the bladder, stomach and bronchi. The efforts expended

in the diagnosis of vesical tumors could only be of academic interest since several biopsies could be done with less difficulty and greater yield.

Chapters on cancer of the thyroid, Hodgkin's disease and the leukemias review the experience of the author and that of others in the treatment of these conditions with radioactive isotopes; the bibliographic references are profuse and reveal wide knowledge of the world literature. In the treatment of cancer of the lung the author employs the successive application of nitrogen mustards and radioactive phosphorus; the hematologic alterations may be profound but rapid recovery is observed. Three patients with carcinoma of the lung thus treated are reported living over one year. No evidence is brought forth to support the author's assertion that radiophosphorus is indicated to avoid the hematogenous spread of melanomas, prostatic, renal, mammary and bone tumors.

This book's message is enthusiastically presented; it is probably the best available publication on the subject in the Spanish language and contains a valuable list of references in several languages.

J. A. del Regato, M.D.

Experimental Nuclear Physics. Volume I. Edited by E. Segrè. Cloth. Price, $15.00. Pp. 789. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, 1953.

This volume represents the first of a series projected to cover adequately the field of nuclear physics up to the end of 1951. In the preface the editor rightly points out that the subject matter has grown to such proportions as to be beyond the adequately descriptive capacity of any one person. The recourse to collaboration of experts in the various specialized branches may have brought some lack of unity in the overall treatment, but has indisputably engendered a discriminatingly thorough coverage of excellent didactic value to the student and the research worker in the field.

This volume is divided into five parts: The first, by H. H. Staub, is devoted to detection methods of charged particles. In 165 pages the author has managed to cover fundamental principles, electronic instruments and typical constructions and methods of operation of counters and cloud chambers. The presentation is necessarily concise but ably complemented by a generous bibliography.

The second part, by H. A. Bethe and J. Ashkins, covers in about 200 pages the passage of radiations (heavy particles, electrons and gamma rays) through matter. This excellent presentation will prove of great value to the radiological physicist because of the thorough coverage of the subject matter and the stimulating comparisons with theory. The annotated bibliography extending for nearly nine pages will prove invaluable to the research worker interested in experimental details which could not be treated in the relatively restricted space.

The third chapter, by N. F. Ramsey, entitled "Nuclear Moments and Statistics," covers admirably the theories of interaction between nuclei and atomic and molecular fields, the experimental methods of measuring nuclear moments and statistics and the results obtained.

In the next chapter, the same author deals with salient features of present-day nuclear theory. After an introduction to the nature of nuclear forces, nuclear two body problems are surveyed: the deuteron, neutron-proton and proton-proton scattering. The chapter closes with the treatment of heavier nuclei and discussion of the evidence in favor of nuclear shell structure.

The last chapter, by K. T. Bainbridge, covers the field of mass spectroscopy. After a historical introduction, the author presents a masterly treatment of the theory of deflection and focusing of charged particles in magnetic and electric fields. Next, the relative abundance of isotopes and its applications are introduced, followed by a discussion of possible sources of error in mass spectrometer measurements. Finally, the measurement of isotopic weights by different spectrometric techniques are discussed and valuable pertinent tables are included.

While the general excellence of this volume is hardly to be questioned, it is doubtful that the general radiologist will profit by its reading because this is not an elementary book. The radiological physicist will instead find it useful in two respects: as a valuable source of material in subjects of direct concern and as a concise review of subjects somewhat more remote from, but nevertheless of more than casual interest in his profession. The typographic make-up is good, the illustrations impeccable but the price will be found definitely high by many young physicists.

L. D. Marinelli

Pharmacology and Toxicology of Uranium Compounds. Parts III and IV. Edited by

Carol Voegtlin, Ph.D., Lecturer in Cancer Research and Toxicology, School of Medicine and Dentistry, University of Rochester; formerly Chief of the Division of Pharmacology, National Institute of Health, U. S. Public Health Service; formerly Director of Cancer Research and Chief of the National Cancer Institute; and Harold C. Hodge, Ph.D., Professor of Pharmacology and Toxicology, School of Medicine and Dentistry, University of Rochester. Cloth. Price, $18.00. Pp. 1087–2466, with illustrations. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York, 1953.

Parts III and IV of this volume are each under a separate cover. Part III is concerned chiefly with chemistry, biochemical methods, oral toxicity of uranium compounds, and toxicity following inhalation for one to two years. Part IV covers the mechanisms of uranium poisoning and is directed toward the bone deposition of uranium and the inhibition of carbohydrate metabolism by solutions of hexavalent uranium. There is an extensive bibliography on the biological effects of uranium. Hodge presents an 88 page résumé covering Parts III and IV.

The chapters of the two books are written by many different investigators associated with the research, and the presentation is from the viewpoint of the experimentalist. The charts are all beautifully done and uniform throughout.

The books are lithoprinted by Edwards Brothers and present an unusually fine appearance. Quite apart from the pharmacology and toxicology this contributes to our knowledge of the normal mechanisms of calcification and cellular metabolism.

WALTER H. SEEGERS, Sc.D.

BOOKS RECEIVED

THE YEAR BOOK OF RADIOLOGY (1953–1954 SERIES). Radiologic Diagnosis edited by John Floyd Holt, M.D., Associate Professor, Department of Roentgenology, University of Michigan; and Fred Jenner Hodges, M.D., Professor and Chairman, Department of Roentgenology, University of Michigan; Radiation Therapy edited by Harold W. Jacox, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief, Radiation Therapy Division, Radiologic Service, Presbyterian Hospital, New York City; and Vincent P. Collins, M.D., Professor and Chairman, Department of Radiology, Baylor University, College of Medicine; Radiologist-in-Chief, Jefferson Davis Hospital, Houston, Texas. Cloth. Price, $8.00. Pp. 462, with 399 illustrations. Year Book Publishers, Inc., 200 E. Illinois Street, Chicago 11, Illinois, 1953.

ROENTGEN DIAGNOSIS OF THE HEART AND GREAT VESSELS. By Erich Zdansky, M.D., Professor of Roentgenology, University of Vienna and Director of the Central Roentgen Institute of the Allgemeinen Krankenhaus; translated by Linn J. Boyd, M.D., F.A.C.P., Professor and Director of Medicine, the New York Medical College, Flower and Fifth Avenue Hospitals. First American edition; new enlarged revision. Cloth. Price, $15.50. Pp. 500, with 334 illustrations. Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, New York, 1953.

RÖNTGENANATOMISCHE GRUNDLAGEN DER LUNGENUNTERSUCHUNG. By F. Kováts, Jr., Primarius des Tuberkulose-Forschungsinstitutes; and Z. Zsebók, Dozent an der II. Chir. Universitätsklinik. Cloth. Pp. 288, with 311 illustrations. Kultura, P. O. B. 149, Budapest 62, Hungary, 1953.

THE BREAST IN ROENTGEN DIAGNOSIS. By Raul A. Leborgne, M.D., Head of Radiologic Department of the Instituto de Radiología y Centro de Lucha contra el Cáncer, Hospital Pereira Rossell, Montevideo, Uruguay. English translation by Lucy Crocker de Leborgne. Cloth. Pp. 200, with 307 illustrations. Impresora Uruguaya S.A., Juncal, 1511, Montevideo, Uruguay, 1953.

SOME OBSERVATIONS ABOUT THE NORMAL CEREBRAL PHLEBOGRAM AND ITS VARIATIONS. By Dr. Vladimir Gvozdanović, Zagreb, Yugoslavia. Paper. Pp. 58, with 31 illustrations. Extrait de Rad de l'Academie Yougoslave, Zagreb, Yugoslavia, 1952

THE ROENTGEN ASPECTS OF THE PAPILLA AND AMPULLA OF VATER. By Maxwell H. Poppel, M.D., F.A.C.R., Professor of Radiology, New York University Post-Graduate Medical School; Director of the Roentgen Ray Department, Bellevue Hospital; Consultant in Radiology, Veterans Administration Hospital, Bronx, New York; Consulting Radiologist, United States Naval Hospital, St. Albans, Long Island; Roentgenologist, New York University Hospital; Harold G. Jacobson, M.D., F.A.C.R. Director, Department of Roentgenology, Hospital for Special Surgery, Associate Clinical Professor of Radiology, New York University Post-Graduate Medical School, New York, New York; Attending in Radiology, U. S. Veterans Administration Hospital; Formerly, Chief, Radiology Service, U. S. Veterans Administration Hospital, Bronx, New York; Robert W. Smith, M.D. Senior Resident in Radiology, Veterans Administration Hospital, Bronx, New York. Cloth. Pp. 211, with 150 illustrations. Charles C Thomas,

Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

Grenzen des Normalen und Anfänge des Pathologischen im Röntgenbilde des Skelettes. Von Prof. Dr. A. Köhler, und Doz. Dr. A. E. Zimmer. Cloth. Price, DM 88.—. Pp. 672, with 1282 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New Yor York), 1953.

Tumors of the Thyroid Gland. By Shields Warren, M.D., Professor of Pathology, Harvard Medical School, Pathologist, New England Deaconess Hospital, Boston, Massachusetts; and William A. Meissner, M.D., Assistant Professor of Pathology, Harvard Medical School, Associate Pathologist, New England Deaconess Hospital, Boston, Massachusetts. Paper. Price, $1.75. Pp. 97, with 82 illustrations. Armed Forces Institute of Pathology, Washington 25, D. C. 1953.

Multiple Myeloma. By I. Snapper, M.D., Director of Medical Education, Cook County Hospital, Chicago, Illinois; Formerly, Director of Medical Education, Mount Sinai Hospital, New York, New York; Louis B. Turner, M.D., Research Assistant in Medicine, Mount Sinai Hospital, New York, New York; and Howard L. Moscovitz, M.D., Resident, Second Medical Service, Mount Sinai Hospital, New York, New York. Cloth. Price, $6.75. Pp. 168, with 43 illustrations and 15 tables. Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, New York, 1953.

On Burns. Compiled and edited by Nathan A. Womack, M.D., Professor of Surgery, University of North Carolina School of Medicine Cloth. Pp. 191, with 7 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

Die Bewegungsbestrahlung. Von Dr. F. Wachsmann, Dozent für Medizinische Physik, und Dr. G. Barth, Dozent fur Strahlenheilkunde und Physikalische Therapie, Universität Erlangen. Cloth. Price, DM 36.—. Pp. 192, with 124 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1953.

Die Teleröntgentherapie. Von Prof. Dr. W. Teschendorf, Köln. Paper. Price, DM 8.70. Pp. 72, with 8 illustrations, Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany, 1953.

Radiations and Living Cells. By F. G. Spear, M.D., M.A., D.M.R.E., Member, Scientific Staff, Medical Research Council Strangeways Research Laboratory, Cambridge. Cloth. Price, $3.50. Pp. 222, with numerous illustrations. John Wiley & Sons, Inc., 440 Fourth Avenue, New York, New York, 1953.

The Physics of Radiation Therapy. By Harold Elford Johns, M.A., Ph.D., F.R.S.C., Professor of Physics. University of Saskatchewan; Physicist, Saskatchewan Cancer Commission, Saskatoon, Saskatchewan, Canada. Cloth. Price, $8.50. Pp. 286, with illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

Los Radioisotopos en la Clinica. By C. Blanco-Soler, M.D., Chief of the Medical Service, Central Red Cross Hospital, Madrid, Spain, with the collaboration of Drs. J. W. Otte, A. Salgado, I. Madrigal, Blanco-Soler y Bos, Sanchez Serrano and F. Martino Savino. Paper. Pp. 237, with 57 illustrations. Paz Montalvo, Madrid, Spain, 1952.

Experimental Nuclear Physics. Volume II. E. Segrè, Editor. Cloth. Price, $12.00. Pp. 600, with 73 illustrations and 37 tables. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, 1953.

Collected Papers from King Gustaf V's Jubilee Clinic. Vol. IV. The Radiumhemmet, The Radiopathology Institute, 1949–1950. Paper. Numerous papers, with illustrations. The Radiumhemmet, Karolinska Sjukhuset, Stockholm, Sweden, 1952.

Collected Papers from King Gustaf V's Jubilee Clinic. Vol. V. The Radiumhemmet, The Radiopathology Institute, 1951–1952. Paper. Numerous papers, with illustrations. The Radiumhemmet, Karolinska Sjukhuset, Stockholm, Sweden, 1953.

Berättelse från Styrelsen för Cancerföreningen I Stockholm över Verksamhetsåret 1952. The Radiumhemmet. Paper. Pp. 137, with 25 tables. K. L. Beekmans Boktryckeri, Stockholm, Sweden, 1953.

Stress Incontinence in the Female. By John C. Ullery, M.D., F.A.C.S., F.I.C.S., Obstetrician and Gynecologist, Pennsylvania Hospital; Assistant Professor in Obstetrics and Gynecology, Jefferson Medical College; Associate in Gynecology and Obstetrics, Graduate School, University of Pennsylvania; etc. Cloth. Price, $6.75. Pp. 149, with 82 illustrations. Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, New York, 1953.

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. LEUCUTIA, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

HEAD

KING, GERALDINE, SLADE, HARRY W., and CAMPOY, FRANCISCO. Bilateral Intracranial aneurysms. *A.M.A. Arch. Neurol. & Psychiat.*, March, 1954, *71*, 326–336.

This report is based on 162 angiograms performed on 121 patients suspected of having intracranial vascular lesions. Of the 121 patients, 34 had bilateral angiograms done. Of these 34 cases aneurysms were found in 18, 12 being unilateral and 6 bilateral (33 per cent of those found). The diagnosis of aneurysm was confirmed in 57 of the 121 cases (47.1 per cent). Positive confirmation of aneurysm was higher in those who had hemorrhage (56.7 per cent) than in those without hemorrhage (35 per cent).

In 21 of the 121 patients vascular anomalies were found and 90 per cent of these were confirmed.

The authors stress the importance of bilateral angiography if surgery is contemplated because of the frequency of bilateral aneurysms. They state that their incidence of vertebral artery aneurysms in those which were positive was 14 per cent.—*Frank M. Windrow, M.D.*

SIROIS, JEAN, LAPOINTE, HENRI, and CÔTÉ, PAUL E. Unusual local complication of percutaneous cerebral angiography. *J. Neurosurg.*, Jan., 1954, *11*, 112–116.

Among the local complications described in the literature with respect to percutaneous cerebral angiography are cervical hematoma, irritation of cervical soft tissues, temporary vagus paralysis, transient punctate hemorrhages of the face, neck or eyes, cervical radiculitis, cervical sympathetic nerve paralysis, external swelling, slight tracheal displacement, pain in swallowing and moving the head, and swelling and bruising of the pharyngeal mucosa.

The authors add a previously unreported unusual complication which led to an erroneous roentgenological diagnosis of thrombosis of the internal carotid artery. At the time of the percutaneous injection of diodrast into the common carotid artery, an obliteration of the internal carotid artery was found a few millimeters from the bifurcation. The patient died shortly thereafter from an expanding intracranial neoplasm. Postmortem examination of the common carotid artery showed that the intima had been neatly cut horizontally for about one-third of its entire diameter causing a peeling of the adventitia and forming a valvula which dilated and obstructed the flow of blood into the artery.

Assuming that the intima had been traumatized by manipulation of the needle, it would seem advisable to use a short beveled needle that is as dull as possible. If an arterial block is encountered it might be well to expose the internal carotid surgically to verify the thrombosis and eliminate the possibility of a traumatic valvula.—*Arch H. Hall, M.D.*

KLOSS, K. Ventrikulographiebefunde zum Problem der Volumenzunahme raumbeschränkender Prozesse des Gehirns. (Ventriculographic findings in growth of space occupying processes of the brain.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, April, 1954, *80*, 471–479.

The author discusses 8 cases of his own in addition to 19 cases from the literature. In all these there were normal ventriculograms or encephalograms in the presence of definite clinical impression of brain tumor. Repeat contrast studies showed displacement of the ventricles several weeks to months or years after the initial normal roentgen findings.

He concludes that displacement of the ventricular system by new growth of the brain is not due to the size and rate of growth of the tumor *alone*. It is also due to changes in the tissues surrounding the lesion which upset the pressure equilibrium between the two sides of the cranial cavity and cause a shift. Edema of the brain tissue is not always seen in the early stages of brain tumor and therefore shift of the ventricles cannot be demonstrated for some time.

Negative ventriculograms do not overrrule a clinical impression of tumor. A repeat contrast study is in some cases successful in only four weeks. This is usually brought out by more definite clinical findings. If there is no change in the clinical picture, a repeat examination after ten weeks is advised. The interval between negative and positive contrast studies does not depend entirely on the histopathology of the tumor. Thus the author found an interval of two years in a case of glioblastoma and of seven months in the case of a meningioma. One case of oligodendroglioma had ventricular shift after two and one-half years, while the other did after ten weeks.—*Frederick M. Reis, M.D.*

NECK AND CHEST

O'BANNON, R. P., and GRUNOW, OTTO H. The larynx and pharynx radiologically considered. *South. M. J.*, April, 1954, *47*, 310–317.

The authors review the normal anatomy shown on the lateral soft tissue roentgenogram of the neck and report on their studies of the pattern of ossification of the laryngeal cartilages.

It is considered important to instruct the patient to vocalize a vowel during the roentgenographic exposure. The authors prefer the vowel "oo" as in this case the entire pharynx appears more relaxed, the vallecula is broader and the laryngeal ventricle is higher.

Anatomically, the first major line forms the ante-

rior margin of the air column, and reaches the vallecula. From this small fossa it extends upward to the tip of the epiglottis. From this point two shorter lines descend. The more anterior one continues to form the anterior margin of the air column through the larynx to reach two transverse bands separated by a zeppelin-shaped air space, the laryngeal ventricle. The upper soft tissue band represents the composite of the false cords and the lower the composite of the true cords. The second minor line arises from the tip of the epiglottis, descends directly to the posterior portion of the larynx and forms the aryepiglottic fold. The second major line arises from the nasopharynx and descends to the upper margin of the thyroid cartilage and then passes forward to fuse with the aryepiglottic fold.

The retropharyngeal space which varies from 3 to 5 mm. in width, and the retrotracheal space, which varies from 10 to 15 mm. in width are extremely important and should bear close scrutiny.

As a rule, inflammatory processes are diffuse, poorly defined and tend to thicken and widen spaces. A draining abscess might show an air pocket or a fluid level.

Tuberculosis is characterized by obliteration of the ventricle and swelling of the arytenoid area and the aryepiglottic fold. The vallecula may be obliterated.

Tumors are more discrete and appear as masses which encroach upon air spaces or columns and displace normal structures. Epidermoid carcinoma is the most common malignant tumor. The benign tumors are the fibromas, hygromas, thyroglossal duct and other cysts.

The authors' material consists of 47 cervical soft tissue roentgenograms of normal individuals from eighteen to ninety years of age. There were 20 males and 27 females.

Ossification of the thyroid cartilage varied in structure in the two sexes. In the male the pattern consisted of a homogeneous fine texture. In the female the structure was coarse and characterized by a network of bone which was irregular and arched.

It is the conclusion of the authors that there is an individually inherited laryngeal ossification pattern which may be modified by sex or unusual illnesses. They believe that a pattern is laid down in the early twenties and is modified only slightly in the ensuing years.—*J. N. Ané, M.D.*

Schoenheinz, W.-D. Das Veratmungs-Ösophagogramm, ein Hilfsmittel zum Nachweis der Bronchostenose. (Respiration esophagogram, an aid in the demonstration of bronchostenosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, April, 1954, *80*, 453–457.

A simple method of diagnosing mediastinal shift is described when fluoroscopy fails to reveal definite shift.

The patient takes a large swallow of contrast material in the supine position. After marking a point on the skin of the lateral margin of the sternum with a small piece of lead, exposures are made in deep inspiration and forced expiration and the shift determined between the marker and the midline of the opacified esophagus.

The esophagus, which is light and only loosely attached to the surrounding tissue, moves at pressure differentials which are too small to move the relatively heavy and fixed heart and great vessels. Mediastinal shift was demonstrated in 16 of 18 proved cases of bronchogenic carcinoma. None of these cases showed definite shift on plain chest fluoroscopy.

Besides central brochogenic carcinoma, lesions such as benign tumors, foreign bodies, mucus plugs, clots, inflammatory bronchial stensosis and aortic aneurysms will also show mediastinal shift. Processes causing shrinking of the lung, pull by pleural scarring, pneumothorax and cystic lung disease also show this phenomenon.

Respiratory shift to the involved side helps differentiate central bronchogenic carcinoma from central pneumonia, enlarged trachea, bronchial lymph nodes and metastases. Shift to the uninvolved side on inspiration or no shift points to complicating factors, particularly when abnormal movement of one or both diaphragms is present.—*Frederick M. Reis, M.D.*

Lindskog, Gustaf E., and Stern, Harold. Diverticulum of the esophagus. *Yale J. Biol. & Med.*, Feb., 1954, *26*, 285–294.

The history of the first reported cases of diverticula of the esophagus is summarized in the introduction to this article. The authors state that they are attempting to coordinate all of the available information. They use the commonly accepted classification with esophageal diverticula being divided into three groups. These groups consist of the pharyngo-esophageal diverticulum, the traction diverticulum and the epiphrenic diverticulum. The anatomy and pathogenesis of these three types of diverticula are discussed.

The symptoms of the various types of diverticula are also discussed. Dysphagia is usually the first symptom of the pharyngo-esophageal diverticulum. The traction diverticulum seldom causes any symptoms and the epiphrenic diverticulum is difficult to evaluate symptomatically because of its frequent association with cardiospasm.

The surgical treatment of the pharyngo-esophageal diverticulum is considered. The two-stage operation of Goldmann and the invagination procedure developed by Bevan are mentioned.

Complications of esophageal diverticula are di-

vided into preoperative (spontaneous), operative and postoperative. Spontaneous perforation is described. The other complications are largely operative or postoperative in nature, although peptic ulceration of an epiphrenic diverticulum is considered relatively common.

The authors reviewed the New Haven Hospital cases seen between the years of 1942 and 1953. They studied 21 cases of pharyngo-esophageal diverticulum, 21 cases of traction diverticulum and 4 cases of epiphrenic diverticulum. The results of diverticulectomy in 16 of their patients are analyzed.—*R. E. Kinzer, M.D.*

GROSS, T. A. Kartagener's triad; report of two cases. *Radiology*, March, 1954, *62*, 347–350.

Kartagener's syndrome consists of situs inversus, bronchiectasis, and paranasal sinusitis. That the simultaneous occurrence of these abnormalities is not fortuitous is borne out by the disproportionately high incidence of bronchiectasis in patients with situs inversus (16.5 to 23 per cent) as compared with that in the total number of hospital admissions (0.3 to 0.5 per cent).

Since the concomitance of situs inversus and bronchiectasis was first noted in 1904 by Siewert, a total of 41 cases has been reported. The author reports 2 additional cases seen at the State of Wisconsin General Hospital. A third case was found among outpatients but the presence of bronchiectasis was not confirmed by brochography.

In a thirty year period, during which time there were 262,000 hospital admissions, 13 cases of complete transposition of viscera were found. Three had associated bronchiectasis and paranasal sinusitis, an incidence of 23 per cent.—*Arno W. Sommer, M.D.*

HESS, ROBERT. Die Lungenveränderungen nach Bronchographie mit carboxymethylcellulosehaltigen Kontrastmitteln. (Pulmonary changes after bronchography with contrast media containing carboxymethylcellulose.) *Thoraxchirurgie*, April, 1954, *1*, 499–510.

Aqueous iodine solutions with a carboxymethylcellulose (CMC) base have to a great extent replaced lipiodol abroad in the past 7 years because of absent residue and lessened pulmonary damage. Numerous claims have been made as to the complete absorption and elimination of the material without causing any harm.

Contrary to the general belief of innocuousness, the author found 100 per cent permanent pulmonary damage in a series of 16 surgical and 3 autopsy specimens. While the iodine is readily absorbed, the CMC base is frequently retained and causes a foreign body reaction. It can be traced on histologic sections, appearing red when stained with thionin. Three stages are recognized histologically and are illustrated by ten photomicrographs.

First Stage: An initial reaction after six to seven days, observed in 5 cases, was characterized by CMC remnants and thickened alveolar septa with hyperemia and round-cell infiltration.

Second Stage: Typical foreign body granuloma occurred in 10 cases with thick CMC remnants, phagocytosis, and foreign body giant cells. The same increased in size and density from the 7th to the 25th day.

Third Stage: Scar formation and fibrotic stage of foreign body granuloma were found in the remaining 4 cases.

According to the author, aqueous iodine solutions with CMC base cause lung damage as frequently as does lipiodol. Therefore, the new type bronchography should be done only if strictly indicated and the same caution is necessary as with oily solutions. No more solution should be instilled than absolutely needed.—*Ernest Kraft, M.D.*

GIUNTOLI, L. Considerazioni sulla sindrome atelettasica del lobo medio e sulla patogenesi di alcune forme massive da silice. (The syndrome of atelectasis of the middle lobe and the pathogenesis of some forms of massive silicosis.) *Gior. ital. d. tuberc.*, Sept.-Oct., 1953, *7*, 3–20.

The author has studied 11 patients affected by silicosis in whom the principal manifestation consisted of atelectasis of the right middle lobe. The pathogenesis of such atelectasis is discussed taking into consideration the various bronchial alterations described in the literature on silicosis.

The author believes that cicatricial bronchial stenosis and subsequent atelectasis play a large role in the roentgen appearance of the silicotic lung. The possibility of confusing such lesions with atelectasis due to carcinoma is stressed.—*Cesare Gianturco, M.D.*

FLEISCHNER, FELIX G., and BERENBERG, ARNOLD L. Idiopathic pulmonary hemosiderosis. *Radiology*, April, 1954, *62*, 522–526.

This rare disease, also called essential brown induration of the lung, occurs for the most part in children and is characterized by hemorrhages in the lung without signs of a generalized hemolytic tendency. The underlying etiologic factor is believed to be primary defective formation of the pulmonary tissue with a lack of elastic elements or a vasomotor disorder, although the true nature and cause of the condition are not yet fully understood. In advanced cases interstitial fibrosis is commonly seen.

Clinically, the patients have a severe iron deficiency type anemia due to repeated episodes of

hemoptysis. Associated symptoms and findings of a chronic anemia such as dyspnea, cyanosis, tachycardia, etc., are also present.

Roentgenograms of the chest show symmetrical homogeneous opacities, most dense in the central portions of the lung. In periods of remission a fleck-like, reticular pattern may be seen. Superimposed infection and atelectasis may complicate the roentgen appearance.

The clinical course, characterized by acute attacks, and the demonstration of hemosiderin in the sputum, gastric washings or lung puncture biopsy should establish the diagnosis. The course is usually intermittent and progressive.—*Donald N. Dysart, M.D.*

McCort, James J., and Pare, Peter J. Pulmonary fibrosis and cor pulmonale in sarcoidosis. *Radiology*, April, 1954, *62*, 496–504.

The literature is reviewed relative to the etiology, incidence and pathology of sarcoidosis. The diagnosis is by (a) histopathologic evidence of the presence of the granuloma, (b) the exclusion of a known etiologic agent, and (c) clinical and roentgenologic evidence of involvement of two or more organ systems.

The clinical case histories and chest roentgenograms demonstrating progressive pulmonary fibrosis on 6 individuals is presented. In 2 patients the findings were confirmed by autopsy.

Although sarcoidosis is in general a benign disease, it is mentioned that in a small percentage of patients severe pulmonary fibrosis may develop, leading to pulmonary insufficiency and right-sided heart failure.—*Everett E. Seedorf, M.D.*

Demy, N. G., and Gewanter, A. P. Correlation of upper lobe vascularization with certain congenital intracardiac shunts. *Radiology*, March, 1954, *62*, 329–336.

The authors call attention to the complex of abnormal cardiac size and contour with infiltration, especially in the right upper lobe, in the newborn, as indicating certain intracardiac shunts rather than atelectasis or pneumonia. The latter two diagnoses are erroneously made more frequently since the symptoms of dyspnea and cyanosis strongly suggest the presence of these conditions.

Eight cases are presented. The cardiac abnormalities found in these cases are transposition of the great vessels and an intracardiac shunt that makes life possible for a few months. Associated with these abnormalities is a hypervascularization of the pulmonary artery which is more evident in the right upper lobe. A high interventricular septal defect of varying size with an associated shunt is another abnormality which causes this picture. Survival up to about nine months is possible. The hypervascularization of the pulmonary arteries extends throughout the lungs. In all cases the pulmonary artery and right ventricle are dilated.

At present these malformations are inoperable and death intervenes due to congestive failure.

The authors conclude with the statement that early right upper lobe infiltration with abnormal cardiac size or shape should suggest transposition of the great vessels as a first possibility and interventricular septal defect as a second.—*Donald N. Dysart, M.D.*

Wyman, Stanley M. Congenital absence of a pulmonary artery: its demonstration by roentgenography. *Radiology*, March, 1954, *62*, 321–328.

Three cases of congenital absence of a pulmonary artery recognized on conventional roentgenograms are presented. In 1 case there were no known associated anomalies while the other 2 had extensive cardiovascular malformations, which in one instance led to death of the patient at the age of twenty.

Roentgenographically, on films exposed with sufficient penetration, the pulmonary artery shadow is seen to be absent. In its place is noted a network of much smaller vessels which form a lace-like pattern in striking contrast to the broad branching vessels usually present. This network of smaller vessels is believed to correspond to the branching bronchial arteries. Other findings consist of a smaller hemithorax on the involved side. Smaller rib interspaces, elevated diaphragm and displacement of the heart and mediastinum toward the affected side are also observed.

Angiocardiography demonstrates well the absence of the pulmonary artery and shows the distribution of the contrast medium in the fine, lacy network of these enlarged bronchial arteries.

It is important to differentiate this anomaly from other more common conditions such as collapse of a lung or of a lobe, or old thickened tuberculous pleuritis which results in a small appearing hemithorax.—*Donald N. Dysart, M.D.*

Blount, S. Gilbert, Jr., McCord, Malcolm C., Komesu, Seiichi, and Lanier, Raymond R. Roentgen aspects of isolated valvular pulmonic stenosis. *Radiology*, March, 1954, *62*, 337–343.

Isolated valvular pulmonic stenosis, one of the congenital cardiac anomalies, is being diagnosed more frequently now that cardiac catheterization and angiocardiography are being used. The authors feel that this diagnosis can be established on the basis of clinical, roentgenographic and fluoroscopic features with a high degree of accuracy without the aid of the above elaborate procedures.

Twenty-three cases were reviewed where this diagnosis was made and confirmed by cardiac catheterization and this paper emphasizes the fluoroscopic and roentgenographic features that have proved to be of diagnostic value.

These features are as follows: vascularity of the lung fields was decreased in varying degree in 14 cases and was within normal limits in 9. Prominence of the main pulmonary artery, a poststenotic dilatation, is a classic and essential feature but it may be obscured when great hypertrophy and dilatation of the right ventricle is present. The amplitude of pulsations of this dilated main pulmonary artery segment was increased in all patients. The size of the right and left pulmonary arteries was normal in most instances but occasionally it may be increased or decreased. The amplitude of pulsations of these arteries was decreased in all cases.

The heart size and configuration showed considerable variation. A prominent right atrial shadow in the presence of a normal ventricular area was considered suggestive of this condition. In the 12 patients with normal heart size a right ventricular hypertrophy was suspected from the characteristic "snubbing" and uplifting of the apical area. The left ventricle and left atrium were within normal limits in all patients.

Other congenital cardiac anomalies that may present a somewhat similar roentgenographic appearence are atrial or ventricular septal defects and patent ductus arteriosus. These are defects which give rise to a left-to-right shunt with an enlarged pulmonary artery. Entities characterized by pulmonary hypertension without an increased pulmonary flow are Eisenmenger's complex, idiopathic pulmonary hypertension and the rare patent ductus arteriosus with reversed blood flow.

Since isolated valvular pulmonic stenosis is now amenable to surgical therapy the early recognition of its presence followed by surgery before onset of right ventricular failure will do the patient a great service.—*Donald N. Dysart, M.D.*

MARKS, DENNIS N., SHAPIRO, ROBERT S., and JOSEPH, LESTER G. Roentgenographic diagnosis of coarctation of the aorta in a two-day-old infant. *J. Pediat.*, Oct., 1953, *43*, 453–456.

This is the report of a case in which the site of coarctation of the aorta was demonstrated on the routine posteroanterior roentgenogram in a two-day-old infant. The clinical course and autopsy findings are presented, as well as a description of the original roentgenogram.—*J. Hale, M.D.*

LEHMAN, J. STAUFFER, and CURRY, JOSEPH L. Radiologic detection of a calcified thrombus within the left ventricle; report of a case with surgical verification. *Radiology*, March, 1954, *62*, 344–346.

Roentgen criteria for recognition of cardiac calcification have been well established. Calcific deposits in the annulus fibrosus, valves, coronary arteries, left atrium, myocardium and pericardium are being frequently described.

The authors present a case report of the roentgen diagnosis of a calcified thrombus within the left ventricle. Careful fluoroscopic observation determining the deep location of the thrombus within the territory of the left ventricle and changes in its position induced by ventricular motion permitted its diagnosis. During surgery for mitral commissurotomy this diagnosis was confirmed by palpation.— *Donald N. Dysart, M.D.*

SOLOFF, LOUIS A., ZATUCHNI, JACOB, and FISHER, HERBERT. Visualization of valvular and myocardial calcification by planigraphy. *Circulation*, March, 1954, *9*, 367–370.

With the advent of cardiac surgery, the knowledge of the presence of valvular calcification has become very important. A comparative study was done on 13 patients using fluoroscopy, conventional roentgenography, Potter-Bucky diaphragm studies with and without supplementary cones and laminagraphy. The latter was done in the left lateral, right anterior oblique or left posterior oblique positions. Sections were made usually at intervals of 1 cm., occasionally at 0.5 cm., at a distance varying from 6 to 15 cm. from the table top.

The authors found laminagraphy to be superior to all other methods.—*George A. Miller, M.D.*

ABDOMEN

STÖSSEL, H. U. Die klinische Bedeutung der Pharmakoradiographie, insbesondere des Morphiums, bei Erkrankungen des Magens und des Duodenums. (The clinical significance of pharmacoroentgenography, especially with morphine, in diseases of stomach and duodenum.) *Schweiz. med. Wchnschr.*, July 11, 1953, *83*, 657–660.

Baensch states that the early diagnosis of cancer of the stomach depends on recognition of changes in form and outline of this organ. The author describes the changes seen in the stomach and duodenum after injection of morphine, based on the previous work of Porcher of France in 1941. These changes consist of:

(1) Increase in tone and size of the stomach.

(2) Strong acceleration in peristaltic waves from body to pylorus.

(3) Increase in amplitude of peristaltic waves.

(4) Definite dilatation of duodenum, secondary to increased filling because of the greater activity of the stomach.

(5) Spasm of sphincter of Oddi.

The above changes are noted in about ten minutes after subcutaneous injection of 0.01 g. morphine hydrochloride and reach a maximum in fifteen to

twenty minutes. The indication for the use of morphine depends on the findings at the first examination. Special attention is then paid to the suspected area of the stomach or duodenum. The author uses it when: (1) there is incomplete, indefinite filling of body, antrum and duodenum; (2) faint peristalsis and little emptying of stomach are present; (3) to demonstrate questionable filling defects of stomach and niches in duodenum; (4) to evaluate contractility of suspicious localized areas of stomach; (5) to localize accurately the pylorus when the antrum is distorted or deformed. Also, if on initial barium meal study, the stomach is large, has no tone and no barium goes through the pylorus, intravenous morphine (0.005 g.) may be given and peristalsis will ensue promptly.

The patient should not be upright after drinking barrium following morphine injection, since it has been noted that its effect is thus weakened. Furthermore, at least 180 to 200 cc. of barium should be taken, since small amounts lessen the morphine action. A low temperature in the room also decreases the effect of the morphine. There are no contraindications to the use of morphine in barium meal examinations. One exception is massive hematemesis because of danger of increasing the bleeding or producing a perforation.

It must be borne in mind that the provoked hypermotility of the stomach may obliterate superficially located changes in the mucosa. Thus, the routine mucosal studies before morphine injection should not be neglected.

Atropine 1 mg. intramuscularly fifteen minutes before examination has also been employed. The author prefers its use in suspected lesions of the bulb, pylorus, and antrum. Recently, Kortuem has used buscopan, a vagal ganglion blocking drug to diminish the tone and peristalsis of the stomach and intestine. Insulin, 10 units intravenously, achieves the same effects as morphine. Feissly adds 0.5 g. larocaine to 50 cc. barium to achieve hypertonicity of stomach. The author's results with this agent have not been good.—*Samuel Richman, M.D.*

KILBOURNE, BURTON C. Coexisting Buerger's disease and giant hypertrophic gastritis; report of a case. *Quart. Bull., Northwestern Univ. M. School*, 1953, *27*, 194–200.

The case history of a patient with a coexisting acute femoral arterial thrombosis and diffuse giant hypertrophic gastritis is presented, with a discussion of the surgical implications and treatment of these entities.

The patient was a thirty-five year old colored man, who was treated medically for a duodenal ulcer in 1942. In 1950 he was treated conservatively for an acute occlusion of the right dorsalis pedis artery. In 1951 roentgen examination of the upper gastrointestinal tract revealed prominent gastric rugae, with suggestion of polyps or tumor. Five days later the patient developed a sudden thrombosis of the femoral artery of the right leg which was treated by lumbar sympathectomy and femoral thrombectomy. Gastroscopy was unsatisfactory because of large rugal folds which filled the gastric lumen. At surgery a large spongy stomach was found with involvement from cardia to antrum and a small, healed duodenal ulcer at the pylorus. Frozen section examination revealed marked inflammatory changes in the wall of the stomach but no malignancy. The author believes the gastric disease was not responsible for the peripheral arterial condition which he feels is a separate co-existing thrombo-angiitis obliterans.

The author gives a brief discussion of the etiology, extent, and preferred treatment of giant hypertrophic gastritis. It is his impression that the majority of such cases are treated surgically because of the uncertain diagnosis and failure of conservative treatment.—*Denis V. Campbell, M.D.*

SANDS, W. WAYNE. The survey roentgenograms as an aid in the diagnosis of acute abdominal conditions. *Surg., Gynec. & Obst.*, July, 1953, *97*, 4–10.

The purpose of this paper is to outline the roentgenographic essentials necessary for proper interpretation of survey films of the abdomen, and the means by which these roentgenograms may be made more useful. Four roentgenograms are necessary for a complete examination of the abdomen; a high and low supine roentgenogram, an upright roentgenogram, and a posteroanterior chest roentgenogram. Portable studies do not suffice.

The author discusses the roentgen appearance of substances of various densities within the abdomen, specifically gas, fat, soft tissues, liquid, calcium, and metal. Gas outside the intestinal tract may be either free in the peritoneal cavity or localized within abscesses and soft tissues of the retroperitoneum. Various authors have reported multiple bubbles of gas within intra-abdominal or retroperitoneal abscesses.

Jejunum, ileum and colon, when distended with gas, have characteristic markings which allow them to be identified roentgenographically. In ileus the survey film shows gas throughout both small and large bowel. The large bowel is seen in a normal anatomic position, and the moderately distended small bowel is seen in the center of the abdomen, with no gross distention of the bowel lumen.

In obstruction, gas is seen in the small bowel but the bowel lumen is greatly distended and the markings are prominent. The loops of small bowel are arranged in a stepladder fashion transversely across the abdomen. Diagnosis of a large bowel obstruction is usually made by identifying a greatly distended colon arranged about the periphery of the abdomen. Gas may or may not be present in the small bowel, depending on whether the ileocecal sphincter is

patent. An early diagnosis of an obstructed sigmoid colon is imperative because of the danger of a ruptured cecum.

In peritonitis, which may occur in a later stage of intestinal obstruction, the psoas muscles are obscured by overlying fluid and fibrin. The properitoneal fat lines are obliterated by edema and inflammation. In the upright position, fluid levels may be noted in the distended bowel loops. Congenital bowel obstruction can usually be diagnosed by survey films. In mesenteric vascular occlusion, if the superior mesenteric vessels are occluded, there may be a distention of the right half of the large bowel ending abruptly at the splenic flexure.

Volvulus of the sigmoid colon may be diagnosed by the presence of large double loops of bowel located in the right upper quadrant with thick edematous walls between the adjacent segments. The differentiating point between volvulus and obstruction due to carcinoma of the sigmoid colon is that the dilated loops of a carcinomatous obstruction do not rise out of the pelvis into the right upper quadrant.

Gallstone obstruction is reported as accounting for 2 per cent of all bowel obstructions. Gas outlining the biliary tract may be seen following erosion of a gallstone into the stomach or bowel.

Intussusception may occasionally be diagnosed on survey films, but is best diagnosed by retrograde barium studies. Dissecting aortic aneurysms may cause an obliteration of the psoas muscle and dorsolumbar scoliosis with a convexity toward the opposite side of the lesion.

Acute pancreatitis may be suspected by an increased opacity in the region of the pancreas, a separation between the gas shadows of the stomach and colon and linear atelectasis or fluid at the base of the left lung.

Patients with ruptured spleens may show serrations along the greater border of the dilated stomach and fracture of the adjacent ribs.

The author finds that survey films of the abdomen are frequently of great aid in the diagnosis of biliary and renal lithiasis, bowel obstruction, ileus, peritonitis, abscess, and ruptured hollow viscus.—*Arthur B. Smith, M.D.*

GOULARD, ALEXANDER, JR. Enteric intussusception; a case report. *Radiology*, Aug., 1953, *61*, 226–230.

The author reports a case of enteric intussusception and correlates the gross and the roentgenographic findings. Complete obstruction of the upper jejunum occurred after a number of previous episodes of flatulence and vomiting, which had subsided spontaneously. Roentgenographic examination showed tremendous dilatation of the stomach and retention of secretions. The duodenum was also distended. Barium was seen to pass approximately 3 inches past the ligament of Treitz, at which point there was an asymmetrical narrowing of the barium column with almost complete obstruction. Operation revealed an intussusception of the jejunum 6 to 8 inches below the ligament of Treitz. Following reduction of the intussusception, a tumor 4 cm. in diameter was found within the lumen of the jejunum 12 inches below the ligament of Treitz. This was reported to be an adenocarcinoma.

Enteric intussusception in the adult is generally due to the presence of a sessile or pedunculated tumor. Complete obstruction is unusual, the intussusception normally being patent and the length of the intussusception being limited by the mesentery. A significant finding is the normal appearance of the mucosa of the intussusceptum.—*Arno W. Sommer, M.D.*

PÁNGARO, JOSÉ ALBERTO, IACOVONE, RODOLFO, and BUITRÓN, PEDRO. Enteritis espruiforme con sindrome de Golden y Kantor. (Sprue-like enteritis with Golden and Kantor syndrome.) *Prensa méd. argent.*, Aug. 14, 1953, *40*, 2147–2152.

A case is described in which prolonged diarrhea of two years' standing resulted in vitamin B deficiency. At the time of examination, glossitis and erythematous skin lesions were observed which were interpreted as manifestations of avitaminosis. The glucose tolerance curve was flattened. Roentgenologic study of the small intestine showed absence and, in other places, exaggeration of normal mucosal folds, fragmentation of the barium shadow and areas of hypertonicity alternating with dilated, atonic loops (syndrome of Golden and Kantor).

The clinical picture improved substantially with administration of intravenous plasma and fluids, blood transfusions, a high protein diet, liver extract and vitamin therapy, but no change was observed in the roentgenological appearance of the small intestine. The diarrhea and symptoms of avitaminosis recurred and the patient died. No autopsy was obtained.—*F. Comas, M.D.*

ASTLEY, ROY, and CARRÉ, IVO J. Gastro-oesophageal incompetence in children; with special reference to minor degrees of partial thoracic stomach. *Radiology*, March, 1954, *62*, 351–362.

The authors see approximately 18 cases of gastro-esophageal incompetence in children annually as compared to about 90 cases of hypertrophic pyloric stenosis. The pathology of the normal valve mechanism between the esophagus and stomach is discussed. When the valve becomes incompetent, there is repeated regurgitation which causes esophagitis. This may develop into ulceration and stricture formation which may account for many cases of so-called "congenital stricture" with a "short esophagus" that is recognized in adults.

Some of the clinical features discussed include vomiting, which may occur with blood or mucus, dysphagia, failure to gain weight, constipation, iron deficiency anemia, visible gastric peristalsis, and feedings taken hungrily.

The roentgen examination is facilitated by a continuous flow of contrast medium, usually through a feeding bottle. This is followed by use of a thick medium given by spoon. Three aspects of the condition must be studied, namely: (1) the gastroesophageal incompetence, (2) the partial thoracic stomach, and (3) esophageal complications.

Gastroesophageal incompetence is demonstrated by the free back and forth passage of barium through the hiatus with respiration or upon forced abdominal pressure.

Recognition of a partial thoracic stomach is based upon the demonstration of the gastric mucosal pattern where both vertical and greater curvature type folds are visible as contrasted to the fine parallel longitudinal lines seen in the esophagus. The hiatus is, as a rule, wider than usual.

Due to esophageal complications, such as ulceration and stricture, it may be difficult to satisfactorily demonstrate reflux or to identify the thoracic stomach. The importance of careful fluoroscopic study is emphasized. The method of recognition and the appearance of esophageal and other complications is discussed.

Conservative treatment is recommended in infants. It is concluded that prompt diagnosis and conservative treatment will reduce the incidence of esophageal strictures and the need of radical surgical treatment.—*Everett E. Seedorf, M.D.*

Pulvertaft, C. N. The post-gastrectomy stomach remnant. *J. Faculty of Radiologists*, July, 1953, *5*, 19–32.

Postprandial symptoms, as unpleasant as the original ulcer, are seen after about 8 per cent of Pólya type gastrectomies for peptic ulceration. Symptoms from recurrent ulceration may be due to gastric, stomal or jejunal ulceration, the recurrence rate depending upon whether the original ulcer was duodenal (average recurrence rate about 5 per cent) or gastric (average recurrence rate about 1 per cent), and upon the extent of resection (about 1 to 1.5 per cent for $\frac{1}{3}$ to $\frac{3}{4}$ resection, and nil for radical subtotal resection).

Symptoms due to mechanical causes may depend upon (a) efferent loop obstruction, or (b) afferent loop stasis and the afferent loop syndrome. In efferent loop obstruction there is a sensation of fullness, nausea and food vomiting, caused by adhesions between the hilus of the spleen and the first few inches of the efferent loop, the adhesions gradually drawing up the efferent loop, producing kinking near the stoma. On roentgen examination, the jejunum anastomosed to the lower pole of the remaining stomach seems to be in constant writhing motion, like a bag of worms. The barium passes into the efferent loop in small spurts, giving the fleeting impression of a question mark. In afferent loop stasis the patient has food vomiting, mixed with bile, occurring one to two hours after meals. Bilious regurgitation is a common, sometimes distressing, post-gastrectomy syndrome which may be seem as (1) intermittent vomiting of rather large amounts of bile-containing material at intervals of one to two months; (2) regurgitation of about one mouthful of bile after a meal; (3) small intermittent regurgitations of bile following indulgence in extra large or rich meals.

Due to alterations in the normal physiology of digestion there occur postprandial fullness, nausea, eructations and so-called vasomotor symptoms of palpitation, perspiration, headache, drowsiness, lassitude, fatigue and weakness of the limbs. The term "*dumping*" implies a sensation of fullness after meals with or without nausea or eructations, and at least one of the above vasomotor symptoms. The symptoms of the "dumping" syndrome may occur either during a meal or up to 15 to 30 minutes after the meal, lasting for 30 to 60 minutes or longer. The late "dumping" syndrome, occurring 3 to 4 hours after a meal, is generally regarded as of hypoglycemic origin. Various hypotheses have been put forward to explain the "dumping" syndrome, including hypoglycemia, small size of stomach remnant, together with rapid filling and distention of the jejunum causing a mesenteric irritation, distention of the afferent loop, size of the operative stoma and psychological factors. Smith in 1951 showed that there is an abnormal fall in serum-potassium electrocardiographic changes characteristic of potassium deficiency and electromyographic evidence of impaired function of voluntary muscle during a "dumping" attack. He thought that the release of some adrenalin-like substance into the blood, and abnormally rapid absorption of ingested carbohydrate, leading to rapid deposition of glycogen and binding of potassium inside the glycogen-storing cells, contributed to this potassium lack.

Roentgenological Investigations. Using a standard barium meal in a patient with symptoms, the stomach usually (not invariably) empties rapidly, producing a sensation of fullness and sometimes nausea, probaly due to jejunal distention. Experiments with hypertonic glucose indicate that the actual absorption of glucose from the small intestine is the basic cause of the "dumping" symptoms. On investigating with actual food there is more tendency for patients with rapidly emptying stomachs to experience symptoms, but with a mixed meal this is not invariably tue. It is possible in general to relate the time of entry of food into the jejunum to the onset of symptoms, and this explains why some patients experience the onset during the meal, while in others it is delayed for 10 to 15 minutes. This relationship is not always true for a mixed meal, but this is due to

the fact that it is the carbohydrate component that is causing symptoms.

In 1950 an attempt was made to treat the "dumping" syndrome with small doses of hexamethonium bromide, on the assumption that it would block autonomic reflexes arising from jejunal distention, but it is more likely that any therapeutic effect is due to the depressant action of methonium salts on the motor activity of the stomach and small intestine. Actually, hexamethonium bromide does appear to modify the symptoms and it is suggested that this is the result of a slowing of the emptying rate of the stomach and a damping down of jejunal activity, leading to slower and more gradual absorption of carbohydrates.—*Samuel G. Henderson, M.D.*

BERGER, I. R., GAY, BRIT B., JR., and WHORTON, C. M. Malignant lymphoma of the stomach. *Radiology*, April, 1954, *62*, 527–535.

The authors review the literature on malignant lymphomas of the stomach and present an analysis of their series of 25 microscopically proved cases. An attempt was made to determine first, if there are sufficiently distinctive roentgen findings to warrant a primary diagnosis of lymphoma; second, if the roentgen findings could be correlated with the gross and microscopic pathology; and lastly, what mode of therapy gives the best results.

Symptoms were those compatible with a clinical diagnosis of peptic ulcer in nearly one half of the patients. Epigastric tenderness and rigidity were the most constant findings on physical examination, while a palpable mass was present in 5 patients.

No roentgen findings pathognomonic of gastric lymphoma could be found. The diagnosis might be inferred from massive gastric involvement by bulky lesions, rigidity of the gastric wall or distortion of the mucosal folds. No correlation was found between the roentgen, gross and microscopic appearance.

Therapeutically the best results were obtained by a combination of surgery and postoperative roentgen therapy.—*Donald N. Dysart, M.D.*

JORUP, SIGVARD, and KJELLBERG, SVEN ROLAND. Roentgenologic studies of the intestine in normal infants and in colonic hyperperistalsis in neurolabile infants. *Acta radiol.*, Feb., 1954, *41*, 109–131.

It is characteristic of so-called dyspepsia in breast-fed infants for defecation to occur during each feeding, often with force and often with pain.

Roentgen studies were done on 38 well children, from one week to four months of age, and on 111 children of both sexes, from two weeks to eleven months of age, suffering from dyspepsia in breast-fed infants. These patients were studied both by barium given by mouth and by contrast enema before, during and after feeding. In order to observe the effects of different factors on the intake of food, examinations were made during: (1) ordinary breast feeding; (2) sucking at a nipple shield without the presence of the mothers; (3) sucking at an empty breast; (4) sucking from a cleansed nipple; (5) bottle feeding (breast milk, citric acid milk, and cow's milk mixture); (6) tube feeding; (7) spoon feeding; (8) fondling the child without feeding.

No difference between the normal and dyspeptic infants could be observed with respect to the appearance of peristalsis or emptying of the stomach, or to the transit rate in the small intestine.

The colon of dyspeptic infants, however, showed strong contractions beginning in cecum about 1½ minutes after feeding was started, and often associated with pain and forceful defecation. In normal infants no significant motion of the colon was observed under similar circumstances.

It was noteworthy that a higher pressure was often required (80 cm. of water as opposed to 50 cm.) for injection of the enema in dyspeptic infants. Pressure readings in the rectum of normal children did not exceed 60 cm. of water, whereas in the dyspeptic children variations were great and pressures often exceeded 100 cm. of water.

The dyspeptic infants showed this reaction when fed by either breast or bottle and it also occurred, but much less consistently, when fed by spoon, tube, or sucking on a nipple shield, or sucking from an empty breast or a washed breast. It did not occur when the mother fondled the child without feeding it.

Treatment with skopyl (0.05 mg. of methyl scopolamine per drop) twenty to thirty minutes before each feeding controlled the symptoms satisfactorily. Doses ranged from 1 to 3 drops. Treating by change of composition of food appeared to be of little or no value.

Dyspeptic infants, practically without exception, exhibit neurolabile symptoms. Their relations are also to a great extent neurolabile and show a higher incidence of nervous gastrointestinal symptoms than the relations of normal infants. The term "colonic hyperperistalsis in neurolabile infants" is suggested. —*Lois Cowan Collins, M.D.*

LING, JI-TOONG. Intussusception in infants and children; with emphasis on the recognition of cases with complications. *Radiology*, April, 1954, *62*, 505–513.

Intussusception is the commonest cause of acquired intestinal obstruction in infants and children. In the absence of complications, reduction by hydrostatic pressure is more desirable than surgical reduction, but hydrostatic pressure reduction is contraindicated in the presence of complications. It is therefore important to differentiate between complicated and uncomplicated cases. Duration of intussusception does not play a significant role in determining

the presence or absence of a complication. Physical findings will include a palpable mass which is usually tender in complicated cases. Fever and leukocytosis may be present or absent in the presence of or lack of complications.

The roentgen demonstration of small intestinal dilatation and/or peritonitis should be regarded as evidence of complication even in the absence of clinical findings. Simple idiopathic intussusception is a nonobstructive process and therefore is generally unassociated with roentgen signs of intestinal obstruction. A barium enema study is conclusive in establishing the diagnosis of ileocolic intussusception and should be used in all doubtful cases.—*Everett E. Seedorf, M.D.*

Matthews, F. J. C. Enteric pneumatosis. *Brit. M. J.*, April 10, 1954, *1*, 851–852.

Enteric pneumatosis is a condition in which, for unknown reasons and by an unknown mechanism, intestinal lymphatic channels become blocked and distended by gas, producing multiple subserous and submucous gas cysts. These cysts usually occur in multiple grapelike clusters, are more common on the mesenteric aspect, and are confined to the small intestine and proximal half of the large intestine. The condition has been described mostly in men of thirty to fifty years of age; it causes vague digestive and abdominal distress, and resolves spontaneously.

The author reports a case in a forty-nine year old woman whose symptoms, including the intermittent passage of bright red blood, had been present for eighteen months. At sigmoidoscopy, sessile, lymphangioma-like polypoid lesions were seen in the lower sigmoid. A barium enema study revealed rounded filling defects in the sigmoid and descending portions of the colon only. The distal transverse, descending and sigmoid portions were resected, an end-to-end anastomosis performed, and the patient has been well for two years. The pathologist reported subserous and submucous gas-filled cysts with incomplete endothelial lining and beginning giant cell formation.—*George Cooper, Jr., M.D.*

Renck, Lars. Experiences with telepaque, a new cholecystographic medium. *Acta radiol.*, April, 1954, *41*, 336–342.

At the Karolinska Sjukhuset in Stockholm, the gallbladders of 130 unselected patients were examined, 64 with 3 gm. telepaque and 66 with 6 gm. bilitrast (priodax). The two series were composed of roughly comparable cases. Side-reactions occurred with slightly less frequency in the patients who received telepaque.

The differences between the two series in the frequencies of filled and nonfilled gallbladders were not statistically significant. However, the contrast filling of the functioning gallbladders was much more intense with telepaque; 74 per cent of the cases showed excellent filling with telepaque as compared with 35 per cent with bilitrast.

All patients in the telepaque series were given a fatty meal and then re-examined by roentgen rays. Good visualization of the cystic duct was obtained in 56 per cent, of the bile duct in 25 per cent, and of the hepatic duct in 2 per cent. The author found that better filling of the ducts was obtained if the patients were kept in the supine position a few minutes preceding the exposure to allow the heavier and denser fraction of the contrast medium to enter the ducts.

In 44 per cent of the bilitrast cases and in 20 per cent of the telepaque cases, it was considered necessary to obtain additional exposures twenty-four hours later, after a second dose of the contrast medium was administered. The second dose frequently produced greater filling of the gallbladder.

The author concludes that for observation of filling of the gallbladder and the biliary ducts, telepaque is superior to bilitrast as a contrast medium.—*Arthur S. Tucker, M.D.*

Henrard, E., and Van Rossum, R. A propos de la nouvelle méthode de cholecystographie et de cholangiographie par voie intraveineuse. (A new intravenous method of cholecystography and cholangiography.) *J. belge de radiol.*, 1954, *37*, 15–40.

This is one of the first reports on biligrafin, a new intravenous drug for the rapid visualization of the bile ducts and gallbladder. It is a bisodium salt of di (3-carboxy-2, 4, 6, tri-iodoanilide adipinic) acid and contains 6 iodine atoms in one molecule. It is well tolerated and only slightly toxic.

In 37 cases the authors found nausea three times and slight skin itching four times. The method is contraindicated in serious liver disease, hyperthyroidism and iodine sensitivity.

The advantages over other drugs are physiologic absorption and secretion and bile duct visualization even after cholecystectomy. Already ten minutes after injection the hepatic ducts are visualized and the drug is completely excreted within forty-eight hours. For a sensitivity test only 2 cc. is injected and if no reaction develops within two minutes, the remaining 18 cc. follows without an additional puncture.

The authors recommend an initial film 20–25 minutes after injection and a two hour film for maximum density. Following ingestion of a test meal, the emptying is studied after five minutes and 30–60 minutes later. For good visualization of bile ducts after cholecystectomy a total dose of 40 cc. is necessary. It is important that the patient be completely immobilized during the examination. Films are then exposed after ten, twenty, thirty and forty minutes.

Eight reontgenographic reproductions illustrate the advantages of the method and a drawing shows the rapid pathway of drug elimination.

The new drug is indispensable in the postcholecystectomy syndrome for study of gallbladder stumps, of calculi in common and hepatic ducts and of dyskinesia of bile ducts with stenosis, spasm and atony of the sphincter of Oddi.—*Ernest Kraft, M.D.*

CAROLI, J., PORCHER, P., GILLES, EV., LEDOUX, J., and CHARPENTIER. La place de l'angiocholégraphie intraveineuse dans le diagnostic des affections de la voie biliaire principale. (The place of intravenous angiocholography in the diagnosis of diseases of the main bile ducts.) *Arch. mal. app. digest.*, March, 1954, *43;* 285–304.

Intravenous angiocholography uses biligrafin, Schering (cholografin, Squibb in the United States). No details of the procedure are given, the reader being referred to the German literature. The present authors only add that several films may be necessary and that they must be processed carefully preferably by the radiologist himself in order to obtain optimum visualization. The report is not concerned in making a comparison with routine oral cholecystography. The authors deal primarily with visualization of the biliary system after cholecystectomy and with a poorly concentrating gallbladder. In 110 cases during the past six months, angiocholography was compared with the excretion of bromsulfonphtalein (B.S.P.) in the bile as well as cholangiography and pressure measurements in the common duct during surgical exploration.

The authors re-emphasize what was noted previously by the German workers that since the contrast substance is carried by blood protein, angiocholography may fail when there is a distinct disturbance in the electrophoretic pattern. They encountered 2 such cases in the absence of cirrhosis or other histopathologic change in the liver. Flocculation tests and the B.S.P. tests were normal. In cases of jaundice and when the bilirubin exceeds 20–30 mg. per thousand, intravenous angiocholography may fail and investigation must be done by the older methods during surgical exploration.

When biliary retention is absent or insignificant, the B.S.P. test is a good frame of reference. When it is normal one can count on the success of the angiochologram. A satisfactory result is possible when the retention does not exceed 20 per cent in forty-five minutes, although the visualization may be delayed. Retention of more than 30 per cent in forty-five minutes usually results in no visualization and they have called this condition "excluded common duct." In the absence of jaundice, marked retention of B.S.P., which makes intravenous angiocholography unusable, may be due to either a primary diffuse change in the liver parenchyma or to a latent obstruction of a main biliary duct. The authors discussed in previous reports retention of hepatic origin as differentiated from that of canalicular origin by measuring the time of B.S.P. appearance in the bile after intravenous injection. They say that when this test is performed correctly it is usually of great diagnostic value. Nor is it outmoded by intravenous angiocholography since the tests are complementary.

Angiocholography is not recommended as a routine procedure in jaundiced patients with retention but in certain cases a delayed angiochologram may be important, where the biliary obstruction appears to be relieved but not necessarily cured.

The study of the sequelae of cholecystectomy constitutes a veritable triumph for intravenous angiocholography, since it is precisely in these cases that the liver clearance gives the best densities in the biliary ducts. In fact the functioning gallbladder will frequently absorb the contrast substance rapidly to the detriment of duct visualization. The authors found that the common duct is normal after cholecystectomy when there is immediate filling, absence of significant dilatation and prompt visualization of the junction of the common duct and the duodenum. Visualization of the intrahepatic ducts need not last much more than two hours. On no film should there be dilatation of the stump of the cystic duct which is ordinarily visualized perfectly. In 13 instances out of 21 cholecystectomized patients, there was an organic explanation for the clinical findings, 6 being due to common duct stone and 7 to spasm of the sphincter of Oddi or papillitis. The latter was evidenced by globular dilatation of the hepatic ducts, stasis of the contrast substance beyond three hours, dilatation of the cystic duct, and, above all, persistence of the contrast substance in the common duct in spite of a fatty meal. Only 1 of these latter patients was re-operated. The diagnosis was confirmed by pressure readings and symptoms were relieved by papillectomy and transpapillary drainage. Histopathological examination of the removed tissue showed a marked fibrous transformation. Intravenous angiocholography is useful when oral cholecystography shows an excluded gallbladder. Surgical experience indicates that, in this condition, about 1 out of 2 cases is associated with common duct stone, and in 2 out of 3, the symptoms arise from the main biliary ducts. Angiocholographic experience is similar. Out of 27 cases, the bile ducts were normal in 8; visualization was insufficient in 6; there was common duct stone in 6; pancreatitis in 4; and definite evidence of papillitis in 3. The procedure is indicated particularly in the undecided or debilitated patient or to ascertain the safety of postponing surgery during pregnancy.

There are many equally important indications for the procedure. In pancreatitis, for example, even if the gallbladder fills and empties satisfactorily, it is unusual for a good functional picture of the bile ducts to be obtained by oral cholecystography. In 1 case, the intravenous procedure showed that the common duct was compressed where it crossed the pancreas; in the second case, the retropancreatic

bile duct was narrowed. Dilatation of the hepatic ducts, prolonged stasis in the main bile duct despite a fatty meal suggests primary papillitis. The relation between certain duodenal diverticula and the choledocho-duodenal opening may be studied. Following gastrectomy, the efferent loop may be visualized. Intravenous angiocholography does not yet replace pressure readings during operation with cholangiography. In at least 20 per cent of cases, the films are difficult to interpret. In 5 cases angiocholography did not visualize stones high in the common duct. False images of stones are sometimes encountered.

The authors emphasize that occasionally the common duct and duodenum are opacified during oral cholecystography even when there is nonvisualization of the gallbladder (Abstracter's comment—older radiologists will remember that this was the basis of the Foote and Carr technique). This visualization is more likely at about seven hours. In discussion of the paper this observation is confirmed but it is pointed out that the visualization ordinarily is inadequate. In discussion, also, it is noted that tolerance to biligrafin is good. The drug should be used cautiously, however, and at least six to eight minutes should be taken for the injection so that it may be stopped if there are untoward reactions. The normal pre-injection tests for sensitivity are used when intolerance to iodides is suspected. Exposures are made every 10–15 minutes for the first hour, then every half hour up to three hours. The intrahepatic ducts are seen best in ten minutes, the common duct in 30–45 minutes, the gallbladder in 15–30 minutes or longer reaching a maximum in about two hours. The gallbladder fills first near its neck, then the contours are defined, leaving a central translucency which might be mistaken for a stone.—*M. L. Sussman, M.D.*

Magistocchi, Luis A., and Aguirre, Juan Alberto. La colangiografía transcutánea; su utilidad en la orientación y solución de problemas quirúrgicos. (Transcutaneous cholangiography; its utilization in the orientation and solution of surgical problems.) *Radiología*, Argentina, 1953, *14*, 39–47.

The method was first tried by Carter and Saypol (*J.A.M.A.*, 1952, *184*, 253–255) following accidental aspiration of bile during liver biopsy. It consists of insertion of a long needle through skin, abdominal wall and liver substance above and to left of the gallbladder, with the needle point aiming toward the liver hilus. When the needle enters the bile duct, a sensation is felt as in venipuncture. After aspiration of bile, 15 cc. of contrast material is injected which will outline the biliary tree like in ordinary cholangiography.

Three cases are reported and illustrated by 11 roentgenograms in which the method made a definite preoperative diagnosis possible and thereby helped to simplify and shorten considerably the surgical procedure.

In the first case with a postcholecystectomy syndrome there was marked pain suggesting a residual biliary calculus; but only a stenosis of the common duct was found and later verified.

In the second case the differential diagnosis was between an impacted stone and malignant neoplasm. The latter condition was recognized and proved surgically.

In the third case the common bile duct was greatly dilated and contained impacted nonopaque calculi. In addition, an inflammatory tumor was also recognized and confirmed.

The method has limited use in postcholecystectomy cases with difficult differential diagnostic problems in which a surgical procedure is contemplated.—*Ernest Kraft, M.D.*

Royer, M., Biempica, L., and Sileoni, V. La colangiografía laparoscópica transhepática. (Transhepatic cholangiography by laparoscopy.) *Prensa méd. argent.*, April 16, 1954, *41*, 1058–1062.

Satisfactory cholangiograms made by laparoscopy require the presence of a visible gallbladder. The gallbladder cannot be visualized in from 15 to 20 per cent of the cases examined by this method. Inasmuch as it is usually these cases in which it is particularly necessary to obtain cholangiograms, a technique has been devised whereby the radiopaque material is injected directly into a hepatic duct.

This examination is conducted under fluoroscopic control. The duodenum is visualized by radiopaque material given by mouth. Following this, the sheath of the laparoscope measuring 18 to 20 cm. in length with a 1 mm. needle is inserted 3 to 4 fingers lateral to the midline and directed to the upper surface of the liver a little to the right and about 3 to 5 cm. from the anterior margin. The needle is inserted into the liver for a distance of from 8 to 12 cm. It is then withdrawn slowly with the sheath maintaining suction with a 3 cm. syringe. If bile is aspirated, it can be assumed that the needle is in a hepatic duct and radiopaque material can then be injected for cholangiograms. This procedure can be repeated three or four times if unsuccessful at first. The injection is very difficult unless the ducts are dilated as in an obstructive jaundice. Successful cholangiograms were made in 4 out of 6 attempted examinations.—*Murray M. Friedman, M.D.*

Dorr, Thomas W. The roentgen diagnosis of gallstone ileus. *Radiology*, March, 1954, *62*, 363–367.

Gallstone ileus represents approximately 2 per cent of all intestinal obstructions in adults. The author believes a diagnosis of this disease can easily be made contrary to some impressions appearing in

the literature. Accurate and early diagnosis is essential to reduce the 50 per cent mortality rate.

The cardinal roentgenographic sign is the presence of air or barium in the biliary tree. Other diagnostic features are the absence or change of location of a previously noted gallstone in an area other than the right upper quadrant, and signs of small intestinal obstruction. Roentgenograms demonstrating these features are reproduced.—*Everett E. Seedorf, M.D.*

POPPEL, MAXWELL H. The roentgen manifestations of relapsing pancreatitis. *Radiology*, April, 1954, *62*, 514–521.

The roentgen manifestations of relapsing pancreatitis are divided into (1) those indicating an acute or subacute exacerbation and (2) those indicating chronic pancreatitis.

1. *Roentgen manifestations of an acute or subacute exacerbation.*
   (*a*) *Duodenum.* In a case of known pancreatitis, enlargement of the vaterian papilla is pathognomonic of a relapse. There may be a functional disturbance of the duodenum such as increased motility, altered peristalisis, spasm or displacement of the bulb. A widening of the duodenal loop occurs with enlargement of the head of the pancreas. Duodenal ileus may occur as a late phenomenon.
   (*b*) *Stomach.* Spasm and irritability early. When the pancreas enlarges there is an elevation and flattening of the greater curvature.
   (*c*) *Pancreatic area.* Palpable mass and tenderness.
   (*d*) *Parapancreatic areas.* Inflammatory tumefactions or collections any place about the pancreas.
   (*e*) *Cholangiographic findings.* Narrowing of common duct and undulation due to exaggerated peristalsis.
   (*f*) *Colon.* Spasm early. Subsequently the mucosa may become edematous with narrowing of the lumen. Depression of mid-transverse colon with enlargement of pancreas.
   (*g*) *Biliary tract.* Gallbladder usually not enlarged, but an opaque calculus may be visualized. In later stage a pancreatic abscess may rupture into the biliary duct system.
   (*h*) *Jejunum and ileum.* Spasm and irritability. Mucosa may become edematous. Segmentation of barium. Displacement from enlarged pancreas. Localized ileus.
   (*i*) *General abdominal roentgen manifestations.* Fluid may be in peritoneal cavity. Adynamic ileus of intestinal segments. Irregular rounded areas of fat necrosis with saponification.
   (*j*) *Diaphragm and chest.* Diaphragm may show slight elevation and restricted motion. Later immobility may occur with subphrenic collections which might perforate into the pleural cavity producing Fleischner liver or empyema.
   (*k*) *Abdominal wall.* Lateral walls of left psoas and quadratus lumborum muscles may become indistinct. Fistulous communication from pancreatic area to abdominal wall may occur.
   (*l*) *Left kidney.* Indistinct, may be displaced downward and outward. There may be impairment of function from extrinsic pressure.
2. *Roentgen manifestations of chronic pancreatitis.*
   (*a*) *Calcaneous deposits* in pancreatic parenchyma, pancreatic ducts and cysts.
   (*b*) *Masses* in and about pancreas due to cysts, collections and abscesses.
   (*c*) *Increase in midline retrogastric soft tissue.* Diameter due to increased size of pancreas.
   (*d*) *Adhesions.*
   (*e*) *Pancreatogenic steatorrhea.*
   (*f*) *Cholangiography.* The upper portion of the common duct is dilated and the lower end exhibits undulated narrowing. The distal end is often bluntly occluded. A stone may be incarcerated at the distal end. The peristalsis of the common duct is altered or absent.
   (*g*) *Osseous system.* Osteoporosis.
   (*h*) *Enlargement of liver* due to pancreatic-hepatic syndrome.—*Everett E. Seedorf, M.D.*

PATEL, JEAN, and LATASTE, JACQUES. L'intérêt de la ducto-pancréatographie pour établir la distinction entre pancréatite et cancer. (Value of visualization of the pancreatic duct in relation to the differentiation of pancreatitis and pancreatic cancer.) *Presse méd.*, April 28, 1954, *62*, 652–654.

Following the observation that the pancreatic duct is often filled during cholangiography, the authors felt that the pancreatic duct could be injected with diodone safely if done slowly and steadily and if the procedure was not performed on hypertensives, arteriosclerotics and severe recurrent epigastric pain. The authors therefore studied the duct following injection in postmortem specimens in 35 cases.

In chronic pancreatitis, the duct was found beaded and dilated irregularly. There were more or less serrated margins to the ampullary dilatation with the intervening segments of normal or narrowed lumen.

Uniform dilatation with rigid, serrated walls was

unusual. A sheet-like opacification of a section of the pancreas also was seen which was speckled in appearance, and due to dilatation of the acini and their efferent canaliculi.

Subacute pancreatitis was associated with a tumor mass in which the duct was essentially normal. All of the mass filled with contrast substance. The canaliculi were filiform in appearance and showed no retrograde filling.

In cancer, the acini did not fill. There were two types of duct patterns. Up stream from the tumor, Wirsung's duct was dilated following the topography of the tumor. With invasion by the tumor, however, dilatation was less marked. There was, in some instances, marked but regular reduction of the lumen. The canaliculi in the area of the tumor, did not fill while those around the tumor filled in a retrograde manner. In isolated cancer, the acini were either normal or obstructed but never gaping as in chronic pancreatitis.

In doubtful cases, therefore, an attempt can be made to visualize the pancreatic duct during cholangiography. Otherwise, transpapillary catheterization of the duct following duodenotomy can be performed.—*M. L. Sussman, M.D.*

Leger, Lucien, Lajouanine, Paul, Cornet, André, and Arnavielhe, Jacques. Le retentissement splénique des affections pancréatiques. (Splenic changes as the result of pancreatic disease.) *Presse méd.*, April 28, 1954, *62*, 656–669.

The intimate relation of the splenic vein to the body and tail of the pancreas explains the effect on the vessel and the spleen which it drains.

The situation may be studied by splenoportography and will account for such manifestations as splenomegaly and gastrointestinal hemorrhage. Pancreatic cancer with extension posteriorly may result in compression or thrombosis of the splenic vein. Portal hypertension localized in the splenomesenteric system is due to compression of the splenic veins by a lesion in the body of the pancreas. Finally there are a certain number of cases of Banti's syndrome in which the primary disease is in the pancreas.

Splenoportography may also give useful information in determining operability.—*M. L. Sussman, M.D.*

Rickham, P. P. Annular pancreas in the newborn. *Arch. Dis. Childhood*, Feb., 1954, *29*, 80–83.

In annular pancreas a collar or ring of tissue surrounds the second part of the duodenum. The author reports on 5 newborn infants with this malformation, its diagnosis and treatment.

The various symptoms and the age at which they occur is apparently determined by the degree of constriction of the duodenum by the encircling pancreatic tissue. In the newborn infant they are severe.

The roentgenologic study confirms the diagnosis of duodenal obstruction, although there is nothing typical for the specific etiology of this obstruction. At operation the diagnosis may be missed in an infant unless the proximal duodenum is dissected free. In children, duodeno-duodenostomy around the constricting ring of the pancreas, if practical, is the ideal treatment. Otherwise, a duodenojejunostomy should be performed.

The author describes his 5 cases in the newborn with appropriate microscopic sections, roentgenograms and clinical photographs.—*Lawrence A. Davis, M.D.*

Jewell, F. C., and Kline, John R. The purged colon. *Radiology*, March, 1954, *62*, 368–371.

Three cases of marked changes in the colon due to excessive cathartics are presented. Aloin and podophyllum were present in all three laxatives used.

It is presumed that prolonged and excessive irritation of the colonic mucosa keeps it edematous and that fibrosis could well occur in the submucosal structures. The constant stimulation of the musculature may cause the muscle fibers to lose their tone resulting in the typical dilatation and atonicity as demonstrated on the reproduced roentgenograms.

This roentgenographic image may be misinterpreted as one due to an old burned-out ulcerative colitis. An adequate clinical history should leave no doubt as to the diagnosis.—*Everett E. Seedorf, M.D.*

Gynecology and Obstetrics

Lieberman, Julius; Segal, Gerald, and Andreson, Paul S. Simplified roentgen cephalometry. *Am. J. Obst. & Gynec.*, Jan., 1954, *67*, 76–78.

Five hundred cases of pelvimetry were reviewed and it was found that the greatest fetal head size, occipitofrontal as well as biparietal, could be accurately determined.

Three 14 by 17 inch films of the pregnant patient are exposed within the last two weeks of the estimated date of confinement. Anteroposterior films are exposed at 25 inch and 40 inch tube-film distance. A third film is exposed in lateral projection with patient reclining at 36 inch tube-film distance and with a centimeter calibrated lead rule placed between the patient's buttocks.

The occipitofrontal diameter of the fetus is measured directly from the "40 inch" anteroposterior film. If it can only be measured on the lateral film the difference in fetal head size between the "40 inch" and the "36 inch" film is negligible. The biparietal measurement is made of the fetal head usually on the lateral film.

The measurements found at pelvimetry were cor-

related with direct fetal head measurements made within twenty-four to forty-eight hours after birth. The data in 500 cases revealed that:

Clinical biparietal diameters = roentgen measurements minus 1.8 cm.

Clinical occipitofrontal diameters = roentgen measurements minus 1.5 cm. —*Robert K. Arbuckle, M.D.*

GENITOURINARY SYSTEM

THORNTON, W. NORMAN, JR. Late urinary system complications following radical hysterectomy for carcinoma of the cervix. *Am. J. Obst. & Gynec.*, April, 1954, *67*, 867–882.

The author presents a highly selected group of 33 cases of Stage I and II carcinoma of the cervix to show the types of urinary complications which were seen following radical surgery. Some received preliminary external irradiation, some radium, and 17 cases were treated only by radical surgery.

All patients were studied preoperatively, and had normal pyelograms.

The ureters had catheters in place during surgery. There were no ureteral, vesical or intestinal injuries at the time of surgery.

Postoperatively, there was considerable difficulty in establishing normal bladder control. Urinary tract infections were frequent. Two patients developed ureterovaginal fistulas which closed spontaneously.

Six patients developed upper urinary tract complications, including unilateral nonfunctioning kidney or hydronephrosis. These have produced no symptoms. They were probably due to periureteral fibrosis and have occurred in patients without preliminary irradiation, as well as in some who had received it.

The most troublesome late bladder complications were incontinence and loss of bladder sensation. Thirteen patients were so affected. These complications have occurred both in patients receiving preoperative irradiation and in some treated only with surgery.

The authors emphasize the necessity of close urologic follow-up postoperatively to prevent the silent development of hydronephrosis and ureteral obstruction.

In the discussion of the paper the point is raised that increased vigorous dissection around the base of the bladder and vesicoureteral areas may be responsible for some of the bladder difficulties.—*George L. Sackett, Jr., M.D.*

BILLINGS, LARS. The roentgen diagnosis of polycystic kidneys. *Acta radiol.*, April, 1954, *41*, 305–315.

The author presents observations on 14 cases of polycystic kidney disease.

The pathologic kidneys, as measured on the roentgenogram (100 cm. focus-film distance), were more than 14 cm. in length and in some instances 16–20 cm., in comparison to 11–13 cm. length in 99 of 100 clinically and roentgenologically normal kidneys. The remaining normal kidney measured 14 cm.

The distance between the most superior and most inferior major calyces of contrast filled pelvis was generally more than 9 cm. and in 1 instance reached 14 cm. in the diseased kidneys, in contrast to 6–8.5 cm. in 99 and 9.0 cm. in 1 of 100 normal kidneys. Similarly, increased thickness of the parenchyma measured as the distance of the lateral outline of the kidney from the nearest laterally directed major calyx was found in the polycystic group. Compared to the normal 2–2.7 cm. and only 1 reaching 3 cm., the thickness of the parenchyma in the polycystic cases was more than 3 cm. and up to a maximum of 4.5 cm.

The author reports that deformity of a calyx or impression on the pelvis was present in nearly all cases and when pronounced or multiple they were highly diagnostic signs.

Polycyclic outline of the kidney, lateral displacement of the renal pelvis, alignment of the long axis of the kidney parallelwith the vertebral column, and a horn-shaped pelvis ampulla (presumably due to enlargement of the parenchyma close to the ampulla) were all extremely difficult to differentiate from variations encountered in normal kidneys. They may prove valuable, however, in indicating the need for additional study such as retrograde pyelography or aortography.

Aortography was performed in 5 cases, but 1 was not technically successful. The author believes that opacification of the parenchyma obtained in this manner differs from that seen in urography in that the former represents capillary filling and the latter nephron filling with the contrast medium. In aortography, the cortex mainly, but in urography the whole parenchyma is rendered opaque. Aortography shows the cortex to have a worm-eaten appearance in polycystic disease due to the presence of cysts of varying size. The normal cortex presents a homogeneous appearance.

The author believes that aortography probably is seldom necessary for the diagnosis, but may be a deciding factor in the doubtful case.—*Thomas B. Efford, M.D.*

ETTINGER, ALICE, and ELKIN, MILTON. Value of plain film in renal mass lesions (tumors and cysts). *Radiology*, March, 1954, *62*, 372–382.

Plain roentgenograms of the abdomen will give information about the presence of a mass lesion of the kidneys much more frequently than is generally appreciated. Properly exposed films will permit visualization of the renal contours, and the detection of deviation from the normal in a high percentage of cases.

In the authors' material of 67 proved renal mass lesions, 33 were malignant tumors. Twenty-six of

these were visible on plain roentgenograms. There were 32 renal cysts, 22 of which were seen on plain roentgenograms. Roentgen visualization was found to be superior to physical examination for the detection of renal mass lesions. In some instances an abnormal renal contour was the only evidence of a lesion and the renal contours remained normal.

Plain roentgenograms that do not demonstrate renal outlines satisfactorily should be supplemented by additional studies: oblique roentgenograms, laminagrams, and excretory or retrograde urograms. —*Arno W. Sommer, M.D.*

Joelson, James J., Persky, Lester, and Rose, Frederick A. Radiographic diagnosis of tumors of the adrenal gland. *Radiology*, April, 1954, *62*, 488–495.

The possibility of a tumor of the adrenal gland is often suggested by the clinical study of a patient, but the final positive diagnosis usually depends upon roentgen examination. It is usually possible roentgenographically to demonstrate such a tumor. The roentgen diagnosis of adrenal masses may depend upon a soft tissue shadow, faint areas of calcification, renal displacement, or finally, the clear demonstration of a tumor by perirenal insufflation.

A plain film of the renal regions is the first requirement. By this means the soft tissue shadow of a tumor occasionally may be demonstrable. In many instances faint areas of calcification within the tumor will be apparent. The kidney shadow may or may not be displaced. Pyelography is the next procedure. This may confirm or demonstrate renal displacement, which is suggestive evidence of an adrenal mass. The final and most important diagnostic step is the roentgenographic study following the perirenal insufflation of air or oxygen. This will practically always demonstrate an adrenal tumor if one is present. It should be performed only when there are clear-cut indications, since it is not entirely without danger.

The authors describe their technique of perirenal air insufflation. The method is very simple, but it should be carried out in the operating room to achieve perfect asepsis. Air is injected through a 20 gauge spinal puncture needle inserted through Gerota's fascia directly into the perirenal space. They have also introduced the air into the presacral tissues in some of the studies.

Several illustrative cases are discussed.—*Arno W. Sommer, M.D.*

Nervous System

White, James C., and Hanelin, Joseph. Myelographic sign of brachial plexus avulsion. *J. Bone & Joint Surg.*, Jan., 1954, *36-A*, 113–118.

Avulsion of one or more roots of the brachial plexus is a complication which may follow severe injuries of the upper extremity. Three cases are reported in this paper with reproductions of the roentgenograms in all 3 cases.

The myelograms showed diverticula, traumatic meningoceles and subarachnoid pouches. These findings can be explained, according to the authors, by the fact that, in addition to the avulsion of the spinal rootlets, the arachnoid and dura were torn as well. When the roots are avulsed, a cuff of dura-arachnoid is torn out the spinal theca. With retraction and shrinkage of the severed stump, a cavity is created which fills with spinal fluid. It is gradually enclosed by the reformation of the ruptured arachnoid and dura, and a traumatic meningocele is formed. This can be readily filled with radiopaque medium and the presence and extent of root avulsion can be demonstrated by myelography.—*Ralph S. Bromer, M.D.*

Skeletal System

Wolf, H. G., and Psenner, L. Pathologisch-anatomische und klinisch-röntgenologische Studien über die sogenannten Wachstumslinien. (Pathologic-anatomical and clinical-roentgenological studies on the so-called growth lines.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Feb., 1954, *80*, 141–153.

This paper deals with linear densities localized toward the diaphysis near the preparatory calcification zone, which Caffey described in a separate chapter of his "Pediatric X-ray Diagnosis" as the so-called transverse lines.

The authors observed these lines in normal children and in those suffering from acute and chronic illnesses. Very often there were also present marginal lines of the small bones and the vertebral bodies. They were mostly symmetrical, especially at the region of greatest growth intensity.

After these introduction remarks, the authors review the literature on this subject , which shows that different etiological factors may cause the same pathological changes. The authors tried to find what percentage of newborn and young children, who came to autopsy, showed transverse lines of the long bones on roentgen examination. Furthermore, they aimed to determine the anatomical substrata and the etiological factors of the transverse lines. In particular, the differential diagnosis from manifestations of early lues congenita was one of the problems.

In 100 cases which came to autopsy, the whole skeleton was roentgenographed with the following result: 81 cases did not show any transverse lines, 1 case had marble bones (Albers-Schönberg disease) and 18 cases showed transverse lines of decreased or increased density near the calcification zone. The cause of death of these 18 cases was in no way dif-

ferent from that of the other cases. Two cases had shown clinical signs and symptoms of lues congenita. After comparing the roentgen findings with those of the histopathological examination, the authors came to the conclusion that in 17 of the 18 examined cases histopathological examination did not show any evidence of lues.

The transverse lines of increased density corresponded histopathologically to increased calcification in the cartilaginous tissue with diminished osteoblastic activity. Residues of calcified cartilage were also present in the irregular osseous trabeculae. These lines of increased density may be caused by different noxious agents; they are not conclusive of lues. The diagnosis of early osteochondritis luetica cannot be made from the roentgen examination alone.—*Hans Lewin, M.D.*

PARKINSON, CHARLES E. The supracondyloid process. *Radiology*, April, 1954, *62*, 556–558.

The supracondyloid process of the humerus is a phylogenetic vestige of the supracondyloid foramen found in many reptiles and some mammals. In man, this process originates from the anteromedial surface of the distal end of the shaft of the humerus and ends in a roughened point from which a dense fibrous band continues to the medial epicondyle. Unlike simple exostoses and bone spurs, the supracondyloid process has important associated soft tissue anomalies which may produce symptoms and complicate surgical removal.

The process was discovered in 0.4 per cent of 500 consecutive patients who were undergoing routine gastrointestinal examination. This incidence is considerably less than the 1 to 2.7 per cent generally cited in the literature.—*A. Ralph Watson, M.D.*

MCLEARIE, M., and MERSON, R. D. Injuries to the lateral condyle epiphysis of the humerus in children. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 84–89.

This article deals with the mechanism of production and the method of reduction of injuries of the lateral condylar epiphysis of the humerus. These injuries are usually described as affecting the capitulum, but, as noted by Roberts and Watson-Jones, the detached fragment consists of the capitular epiphysis and the lateral third of the trochlea with a fragment (common to all epiphyseal injuries) of the humeral metaphysis.

The usual view is that the extensor muscles avulse the fragment from its bed causing displacement which varies from a downward and lateral displacement (usually also backwards) to rotation of the fragment. The authors regard it as difficult to believe that muscular effort alone would cause this. Moreover, when the medial epicondyle is avulsed, without dislocation of the elbow, the displacement is never marked. Their belief is that the elbow is dislocated posterolaterally, and carries the fragment with it. If the dislocation is incomplete the fragment moves downward, laterally and backwards. If the dislocation is more marked the fragment is pulled backwards. Dislocation associated with fractures renders the joint unstable in all directions. The dislocated joint surfaces can fall forward approximately into their normal position and the fragment lies anterior to the humerus. Clinically no dislocation appears to be present. The authors think that this hypothesis gives the clue to successful closed reduction. The method of reduction consists in redislocating the elbow posterolaterally, then reducing it, when the fragment settles in its bed accurately. The fragment itself does not require to be pressed into position but care must be taken to move the radius and ulna medially to get accurate apposition.

A total of 11 cases were treated with closed reduction, which was successful in all the cases. The authors suggest that this injury should be classified with dislocation of the elbow.—*Ralph S. Bromer, M.D.*

BOLDERO, J. L., and MITCHELL, C. P. Osteochondritis of the superior tibial epiphysis. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 114–115.

So far as the authors are aware no cases of osteochondritis of the superior tibial epiphysis have been reported in the literature. The patient was a boy of twelve years of age who complained of pain in the right knee of three months' duration. Roentgenograms showed evidence of increased density of the upper tibial epiphysis. Roentgen examinations made later showed the greatest density nine months after the onset of the symptoms. Needle biopsy showed a low-grade inflammatory reaction with no evidence of bone absorption or necrosis. An inguinal lymph node removed at the same time was histologically normal. Within a year of the first symptoms, the knee was quiescent. The roentgenogram showed advanced revascularization. Two and a half years after the onset, roentgenograms showed a general improvement in the appearance of the bone.

The diagnosis lay between a pure ischemic lesion and a low-grade infection in the epiphysis. The low-grade inflammatory reaction found on the needle biopsy could be consistent with either lesion. The clinical course and the roentgenographic findings of sclerosis followed by resorption and satisfactory reorganization one year later suggest, according to the authors, that the condition might be classified as an osteochondritis of the superior tibial epiphysis.—*Ralph S. Bromer, M.D.*

HALL, R. MCKELLAR. Regeneration of the lower femoral epiphysis; report of a case. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 116–117.

The author considers the case reported in this

paper to be of interest because after a lapse of at least four years since its destruction, the medial condylar part of the lower femoral epiphysis appears to be regenerating. The patient, a boy who when first seen, was ten and a half months of age, had suffered from suppurative arthritis of the knee joint with epiphysitis of the femur at the age of three weeks. This resulted in complete destruction of the medial condylar part of the epiphysis.

The patient was last examined seven years after he was referred to the author for treatment. The knee was then stable and straight and the range of flexion was 70 degrees. The limb was 2 inches shorter than the opposite. The roentgenograms showed partial regeneration of the medial femoral condyle with regeneration of the epiphysis. The metaphyseal portion, however, was still shorter when compared with the metaphysis of the lateral portion of the shaft.—*Ralph S. Bromer, M.D.*

Webb, J. Hugh, Svien, Hendrick J., and Kennedy, Roger L. J. Protruded lumbar intervertebral disks in children. *J.A.M.A.*, April 3, 1954, *154*, 1153–1154.

Out of approximately 6,500 patients at the Mayo Clinic who had protruded intervertebral discs treated surgically, only 60 were eighteen years or less and only 5 were under the age of sixteen. Two of these were fifteen, one was fourteen, one was thirteen and one was twelve years of age. The clinical and pathological features in these 5 children did not differ significantly from those in adults with similar lesions. The vertebral level of their protrusions conformed with the most frequent sites of protrusion in adults.

Follow-up examinations of and letters from 4 of these patients revealed that good results had been obtained.—*Arthur E. Childe, M.D.*

Gershon-Cohen, J., Schraer, Harald, Sklaroff, David M., and Blumberg, Nathan. Dissolution of the intervertebral disk in the aged normal; the phantom nucleus pulposus. *Radiology*, March, 1954, *62*, 383–387.

Dissolution of the intervertebral discs, with the appearance of a "phantom nucleus pulposus" or "vacuum phenomenon," was found in 27 of 130 aged normal individuals examined by the authors. Only 7 of these patients gave a history of chronic low back ache. In the remaining 20 patients there had never been any complaints referable to the spine. In only 8 cases was the vacuum phenomenon limited to one interspace. The intervertebral space was always narrowed in the presence of the vacuum phenomenon.

Drying out of the disc substance, either as a degenerative change following trauma or as a normal aging process, is probably the basis for the appearance of these phenomena. This drying-out process in the spine may also be responsible for the upper dorsal kyphosis and the diminution in body stature which is so commonly seen in the aged.

Clinical awareness of the phantom nucleus pulposus is important, since laboratory experimentation may follow and lead to a better understanding of an aging process which may be preventable if not reversible.—*Arno W. Sommer, M.D.*

Richman, Samuel, and Friedman, Robert L. Vertical fracture of cervical vertebral bodies. *Radiology*, April, 1954, *52*, 536–543.

A vertical fracture of a cervical vertebral body in the sagittal plane splitting the body into almost equal right and left halves with or without compression or other concomitant fractures is a very unusual one. Routine anteroposterior roentgenograms may show the pathognomonic vertical radiolucent area in the region of the body, but in questionable cases laminagraphy is of great value in verifying the diagnosis. Spina bifida occulta, fracture of the neural arch and overlying air in the soft parts anteriorly are entities which must be differentiated from a vertical fracture.

The authors present 6 cases report with roentgenographic reproductions and discussions out of a series of 17 vertical fracture injuries found among 80 cases of cervical spine injury. All 17 cases were quadriplegic. Associated compression fracture, dislocation and fracture of laminae in various combinations were present in 10. In all these cases, C-5 and C-6 were the vertebral bodies involved either alone or in combination.

The mechanism of occurrence of the vertical fracture and the mode of cord injury in these cases is discussed.—*Donald N. Dysart, M.D.*

Gershon-Cohen, J., Rechtman, A. M., Schraer, Harold, and Blumberg, Nathan. Asymptomatic fractures in osteoporotic spines of the aged. *J.A.M.A.*, Oct. 17, 1953, *153*, 625–627.

Asymptomatic vertebral fractures in osteoporotic spines of the aged stand out in sharp contrast to the urgency and seriousness of acutely traumatized spines in younger persons.

The authors report the results of a survey of 136 aged persons; the age range was sixty-three to ninety-five years. All the persons were ambulatory and in good health. Anteroposterior and lateral roentgenograms of the spine were made as part of the clinical survey in each case.

Vertebral fractures were found in 35 of the 136 cases. Single fractures in the dorsal spine alone occurred in 14 cases and in the lumbar spine in 7 cases. When multiple fractures were present they were con-

fined to the dorsal spine in 6 cases and to the dorsolumbar spine in 9 cases. Multiple fractures always were found in association with one or more fractures in the dorsal spine. The 12th dorsal and the 1st lumbar vertebrae were most frequently affected. Only one or two fractures were found in most spines but there were as many as seven fractures in one case. All the spines revealing the fractures were osteoporotic.

Not a single history of fracture was elicited in this group, and therefore not a single patient was treated for fracture. There were no clinical findings indicating disability. The persons with the fractured vertebrae could not be distinguished from those without fracture. Solid healing of these fractures without special treatment evidently occurs, because the anatomic defect of the fractured vertebra, even though marked sometimes, does not interfere with the stability of the spine.—*H. Neucks, M.D.*

STRULLY, KENNETH J., and HEISLER, SAUL. Lumbar and sacral cysts of meningeal origin. *Radiology*, April, 1954, *62*, 544–549.

Meningeal cysts of the lumbar and sacral region are an infrequent cause of low back pain. These cysts may be of two types—congenital and acquired. Clinically the pictures are not typical of the common causes of low back and sciatic pain such as ruptured disc. Myelographic studies may or may not demonstrate the cyst filled with opaque medium, or may show pressure on the dural sac in a location atypical for a ruptured disc.

The authors present 5 cases of lumbar and sacral meningeal cysts. Four were proved surgically and the fifth was not proved. A sixth case representing a proved true perineural cyst is also presented.

Attention is again called to the sacral canal where unsuspected lesions may be found, sometimes only at operation.—*Donald N. Dysart, M.D.*

QUINLAN, A. G. Post-tetanic kyphosis; report of a case. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 80–83.

The occurrence of post-tetanic kyphosis from multiple fractures of the spine is interesting in that it might appear at first sight that compression fractures have been produced by a hyperextension force—an apparent contradiction of the usually accepted views on the mechanism of this injury. For this reason, Quinlan states it has been called "a paradoxical symptom complex."

The case reported is that of a girl of seven who, when first seen five weeks after the onset of tetanus, showed a generalized upper thoracic kyphosis, which could not be actively or passively corrected. Roentgenograms showed kyphosis with marked flattening and wedging of the bodies of the fourth, fifth and sixth thoracic vertebrae, and to a lesser extent, wedging of the third, seventh and eight. There was some sclerosis of the affected vertebrae. The discs were unaffected.

There seems little doubt, according to the author that in this case the hyperextension spasm of the tetanus produced crush fractures of the vertebral bodies. Several hypotheses have been advanced by previous writers to explain the production of these fractures: Toxic theory—Tetanus toxin is stated to have a direct action on bone causing an osteoporosis and weakening which leads to collapse. Vascular theory—Repeated spasms of muscles round the vertebrae, compress the nutrient vessels, and produce congestion, according to some writers and anemia according to others. "Tetanus en boule"—A rare form of tetanus in which spasms are frankly flexor in character and in which crush fracture would be expected. Mechanical theory—The area of the spine affected by collapse after tetanus is remarkably constant. T5 is the vertebra most commonly affected, with T6 the next in frequency. Often as many as six or seven vertebrae show varying degrees of change, but the apex of the gibbus so produced is always at T5.

Previous writers have pointed out that the force acting on the whole vertebral column as a result of simultaneous contraction of the flexors and extensor muscles is one of longitudinal compression. This will have the effect of forcibly increasing the normal spinal curves. Thus hyperextension of the lumbar and cervical regions will occur and the patient will lie in the classical position of "opisthotonus;" but in this position the upper thoracic spine is acutely flexed.

Other previous writers state that the spinal muscles are weakest in the upper thoracic region, the interspinales being frequently absent. The full force of the trunk flexors, acting through the leverage of the ribs, would be concentrated at this point and flexion would be produced here. In addition, it was demonstrated that the upper thoracic vertebrae were the weakest in the spinal column. Moreover, their ability to withstand any compression force was reduced by submitting them previously to repeated blows, each one in itself insufficient to produce collapse. This would explain the production of vertebral crush fractures by repeated muscle spasms of tetanus.

The author thinks that a combination of these mechanical theories seems to give a satisfactory explanation of the production of the vertebral collapse. The apex of the thoracic curve would be higher than normal during generalized spasms because of the flexor-extensor balance of the region and this temporary apex would suffer the full compression force. —*Ralph S. Bromer, M.D.*

DE FEO, EDWARD. Osteomyelitis of the spine following prostatic surgery. *Radiology*, March, 1954, *62*, 396–401.

The author presents 2 new cases of osteomyelitis

of the spine following prostatectomy and 6 others from the literature are reviewed. The method of spread of infection up the vertebral vein system is discussed.

Severe back pain is an outstanding symptom and this is best relieved by immobilizaiton in a plaster jacket.

The roentgen findings include localized vertebral destruction and usually associated severe disc destruction. A paravertebral mass may occur.—*Everett E. Seedorf, M.D.*

Enticknap, J. B. Albers-Schönberg disease (marble bones); report of a case with study of the chemical and physical characteristics of the bone. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 123–131.

In this paper a case is described of the marble-bone disease of Albers-Schönberg in a woman of forty-one who died from a subarachnoid hemorrhage. Not only are there few records of investigations made at necropsy into the abnormalities of this condition, but there is also considerable divergence of opinions expressed by surgeons on the characteristics of the bones at operation. The author believes that there can be no reasonable doubt that the patient had Albers-Schönberg disease. Although there was no history of fractures and no family history, the disease had been present for a long time and probably from childhood. Necropsy revealed no other cause for bone disease and showed numerous features entirely consistent with such a diagnosis. In addition, several congenital anomalies (multiple intracranial berry aneurysms, a parapituitary epithelial rest and a benign ovarian tumor) were perhaps further evidence that the condition of the patient's bones was the result of a developmental error.

Roentgenograms of the osseous system showed increased bone density in the proximal ends of the femora and tibiae and particularly marked changes in the skull. The skull was so dense that few cranial details and no vascular pattern at all could be seen after right carotid arteriography.

Physical investigations were made consisting of determination of specific gravity of isolated cortical bone, Young's nodulus of elasticity, and breaking strength. The resistance of the bone surface to a standard penetrating force was also determined. The paper includes detailed descriptions of these investigations, methods, apparatus, etc. The physical characteristics of the abnormal bone are the most interesting of the findings and the author thinks that they may have a bearing upon the differences of opinion that have long existed about the disease, such as the degree of fragility of the bones, resistance to a penetrating force and others. The main characteristic of the findings was the marked contrast between the values for the skull and long bones, which, in general, fell on opposite sides of the mean values for the normal tibia. The only exception was the specific gravity, all the marble bones being denser than the mean for the normal tibia. Despite this, the difference between the skull and long bones was still appparent for whereas the former fell within the normal range, that of the latter was outside its upper limit. Thus the skull was harder than normal and bent and broke more easily, whereas the long bones were softer and more resilient and resistant to fracture. Although not all of these deviations are significant, they do suggest, the author believes, that the osseous changes in marble bones are of a patchy distribution, a finding which accords with the roentgenographic appearance in his and other cases. He suggests that the simple investigation of determining the breaking strength of cortical bone yielded results similar to the more complex investigations and if applied to a larger series of cases could provide sound data on which to base speculations about this condition.—*Ralph S. Bromer, M.D.*

Buxton, St J. D., and Waugh, W. Radiographic bone changes at the hip after insertion of an acrylic prosthesis. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 50–56.

The object of this paper as stated by the authors is to report the changes that take place in the upper end of the femur after insertion of an unplasticized acrylic prosthesis. The first change seen in the bony channel in the femoral neck after operation is the development of a linear shadow which appears to outline the transradiant stem of the prosthesis. This consists of a condensation of bone trabeculae which may represent a healing reaction in the raw surfaces left by the reamer. Measurements made in 33 cases showed that in most instances the prosthesis lay in a bony channel several millimeters wider than the channel itself. Further investigation with arthrograms showed that the contrast medium trickled down inside the femur around the stem. A clear zone was sometimes apparent between the bone and the opaque material suggesting that the bony channel was lined with a layer of soft tissue up to 2 mm. in thickness. Therefore although the prosthesis was loose, direct comparison between the width of the stem and the diameter of the bony channel gave an exaggerated impression of its looseness. From the authors' study, it seemed likely that the space between the upper part of the stem and the bony channel was largely filled with soft tissue. In a case in which this was observed varus was noted within a year after operation, but thereafter it did not increase. In the 3 cases in which displacement of the prosthesis occurred the operation had been undertaken for recent subcapital fracture. At operation the femoral neck consisted of a thin outer shell of cortex with little compact bone which, together with a deficiency of cancellous tissue, favors angulation of the prosthesis. In cases of osteoarthritis, in which the

bone of the neck provides more adequate support, angulation is slight and the authors believe that there is no reason to suppose that this is detrimental to the functional result, despite undoubted loosening of the prosthesis.

In most cases, the cut edge of bone in the stump of the neck becomes smooth and rounded during the first year after the operation, thus conforming to the undersurface of the head of the prosthesis. If the prosthesis is in valgus the upper and lower borders of the neck appear equally well developed. If the prosthesis has been placed in the neutral or varus position, there is usually sclerosis and obvious buttressing of the lower border.

When the prosthesis reaches, but does not penetrate, the lateral cortex of the femur below the trochanter alterations in the normal bony structure take place and can be seen as early as six months after the operation. These changes are the result of weight-bearing. There is first, condensation of trabeculae below and around the end of the stem, forming a triangle or ledge of bone which undoubtedly helps to support the prosthesis. Secondly, subperiosteal new bone is frequently laid down on the lateral cortex opposite the end of the stem. These two reactions were frequently present, either separately or together depending on the angle of the prosthesis.

The authors observed roentgenographic changes only occasionally in the acetabulum. They were usually asssociated with a tendency to subluxation when the weight-bearing surface was concentrated over a relatively small area. Sometimes in these instances, sclerosis and erosion were produced which were not present before operation. When subluxation occurred the unoccupied part of the acetabulum became filled presumably with fibrous tissue as shown by arthrograms.

New bone formation in the soft tissues around the hip may occur after any form of arthroplasty. Only twice in the series did it account for the cause of the pain and limited motion. In 6 patients small fragments of bone were present but they did not interfere with function.

The authors note that the study of the roentgenographic appearances after replacement arthroplasty helps to clarify some of the doubts that have arisen about the reaction of bone to pressure from an inert material. In no case in their series has the neck shortened to any appreciable extent. In fact, the roentgenographic appearance suggests that the prosthesis becomes stabilized after about a year and a half, and there is no reason, they believe, that deterioration should occur.—*Ralph S. Bromer, M.D.*

Lewitan, Alexander, and Nathanson, Louis. Osteitis ischii and pubis following abdominoperineal resection for carcinoma of the rectum; case report. *Radiology*, March, 1954, *62*, 402–405.

Osteitis pubis following abdominoperineal resection for cancer of the rectum is a rare complication, and the authors were able to find only one similar case reported in the literature. In such patients it is important to exclude osteomyelitis and metastatic cancer because of the difference in prognosis and treatment. Osteitis pubis is probably a self limiting process.

The main roentgenographic feature in the case reported was periosteal involvement. Early, there was osteoperiostitis of the ischial tuberosity on one side with minimal changes in the os pubis. Later both ischial tuberosities became involved and marked pubic separation occurred, with normal bone between the ischii and the os pubis. Whether the disease process began in the pubic bone or in the region of the ischial tuberosity is not known.

Radiation therapy was given in two series (initially, 100 r per treatment for a total of 600 r to each of two ports, one anterior and one posterior; and two months later, 75 r per treatment for a total of 300 r for each port). There was dramatic relief of pain and complete cure followed.

The authors contend that milder cases of osteitis pubis probably occur after this type of surgery, possibly due to partial interference with the blood supply of the pubic bone, but are missed because no roentgen examination is done, and because of the self limiting nature of the disease.—*Charles L. Stevenson, M.D.*

Burkitt, Denis, and Fairbank, H. A. T. An unusual lipoid reticulosis of bone. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 109–113.

The patient described in this paper presented an affection of the skeleton which, as far as the authors were aware, had not been recorded previously. The patient was a Muganda boy, aged eight years, with a painful swelling of his left foot and leg. There was no edema and no open or healed sinus shown on physical examination of the leg. The affected leg was 1 inch shorter than the opposite limb. The patient was afebrile while under observation. The lower leg and foot were diffusely enlarged.

Roentgenographic examination of the skeleton showed lesions in the left foot, the left tibia and fibula, and the right humerus. Examination six months later revealed no change in the lesions. In the left leg, the process involved the whole of the tibia and fibula and all the bones of the foot. The bones were irregularly expanded, their cortices were thin, in some places not detectable. The whole thickness of the bones was occupied by fairly widely spaced coarse trabeculae. In the upper third of the fibula there was a core of coarse trabeculae in the normal line of the shaft of the bone, and radiating perpendicularly from it spicules of trabeculation ending in a faint line of calcification marking the new boundary of the bone. The right humerus

showed a cyst-like area in the middle of its shaft. The overlying bone was expanded, and its cortex was thinned. Proximal and distal to the zone of rarefaction, the original roentgenograms showed coarse and thickened medullary trabeculation. No lesion was seen in any other bones of the body and there was no suggestion of "Erlenmeyer flask" deformity in the lower portions of the femoral shafts.

The profusely honeycombed appearance of the changes in the left leg suggested angiomatous infiltration of the bones, but the histological findings ruled this out. The overgrowth of the tibia and fibula was probably explained by the abnormal vascularity of the bones. The lesion in the humerus was compatible with a diagnosis of several different affections, including fibrous dysplasia and one of the lipoidoses, and the histology seemed to point towards the latter. Though the finding of foam cells in a section does not absolutely exclude fibrous dysplasia, the number present and their presence in both humerus and tibia seemed to favor a diagnosis of one of the lipoidoses. The authors suggest that their case must be regarded as belonging to one of the lipoid reticuloses, possibly of the Gaucher type, but the absence of enlargement of the spleen is a strong point against this last suggestion.—*Ralph S. Bromer, M.D.*

Harriman, D. G. F., and Millar, J. H. D. Fibrous dysplasia of bone with skeletal lipoid granulomatosis; report of a case with necropsy. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 95–101.

The case reported in this paper demonstrates the unusual combination of unilateral fibrous dysplasia of bone with lipoid granulomatosis. The disorder was also complicated by a neurological condition in which there were plaques of demyelinization in the central nervous system, an association which so far has not been reported.

The patient, a female aged fifty, had been healthy in childhood. At the age of thirty-seven roentgenography of the right femur, because of lumbar pain and tenderness in the right thigh, showed changes suggestive of Paget's disease. At the age of forty-two roentgenograms of the right tibia revealed changes present there also. A biopsy of the femur at that time showed "interstitial fibrosis." The neck was explored at operation and the left upper parathyroid gland was removed and its histology was normal. At the age of forty-eight roentgenograms of the skeleton showed the following bones affected: right frontal bone, base and vault of the skull, right femur, right tibia and right fifth metacarpal bone. The serum calcium, inorganic serum phosphorus and alkaline phosphatase levels were repeatedly within normal limits. A tentative diagnosis of fibrous dysplasia was made. At the age of forty-eight light brown pigmentation was noted in the right temporal region and the left side of the chin, and smaller patches were present on the back of the right hand and on the front of the legs below the knees. There was little change in the skeletal condition until her death, but when she was fifty, the cutaneous pigmentation had disappeared except from the face. The skeletal lesions were unilateral and in the patient's history there was a suggestion of possible accelerated skeletal growth.

The case showed the characteristics of fibroid dysplasia of bone. The histological findings in the skeleton were in many respects identical with those of fibrous dysplasia. In affected areas of bone only, there was thinning of the cortex, with erosion, replacement of the cancellous marrow by a proliferating fibrous tissue, which formed numerous trabeculae of fiber bone and in which cysts containing gelatinous material were found. No islands of cartilage, such as are occasionally present were discovered. The one uncommon feature was the ubiquitous presence of cholesterol and its esters within large sheets of well formed foam cells, or in the interstices of the mature or old fibrous tissue where it could only be detected by special staining. Foam cells have been noted many times in this disease, but mostly in small islands.

The histological features of the case are in keeping with the diagnosis of skeletal lipoid granulomatosis, and it, nevertheless, presents the cutaneous and skeletal features of fibrous dysplasia with cutaneous pigmentation. There does appear, however, to be a small group of cases of fibrous dysplasia in which foam-cell formation is an integral part of the disease process. The authors can only say that at this time a small proportion of cases of fibrous dysplasia exists in which the skeletal lesion takes the form of a lipoid granulomatosis. Further studies of necropsy and biopsy material, bearing in mind that lipoid may be missed in hemotoxylin and eosin sections, may increase this proportion, and a closer relationship may be discovered between lipoid granulomatosis, on the one hand, and fibrous dysplasia of bone on the other. The diagnosis of fibrous dysplasia has been, perhaps, too freely entertained, and many cases of the monostotic form should be ascribed to an atypical reaction to trauma.

Disseminated plaques of demyelinization were found in the central nervous system. This neurological finding is of interest and adds support, however slight, to the concept of lipoid granulomatosis. Lipoid or lipogranulomatous infiltrates may occur within the neuraxis and have apparently given rise to plaques of demyelinization. Such a derivation for the plaques in the authors' case is an interesting probability, but as they state, far from proved.—*Ralph S. Bromer, M.D.*

Frank, W. W., and Denny, M. B. Dysplasia epiphysialis punctata; report of a case and review of literature. *J. Bone & Joint Surg.*, Feb., 1954, *36-B*, 118–122.

Punctate epiphysial dysplasia is a rare congenital disorder of infancy, affecting mainly cartilage, the soft tissues of the locomotor system, such as muscle and joint capsule and the eyes. The various names given this condiion in the literature are perhaps misleading, as indicating only skeletal affection, whereas the soft tissues and the eyes are also involved. The commonest name used in the American and Continental literature is "chondrodystrophia calcificans congenita." The etiology and pathology are obscure. The clinical picture is variable but certain signs are common to most of the patients described. These are: (1) flexion deformities of joints, most commonly the knees and elbows, ascribed to fibrosis of muscle and joint capsule rather than to changes in the epiphyses; changes in the soft tissue structures give the limbs a swollen appearance; (2) bilateral congenital cataract; and (3) dwarfism of the short limb type as in achondroplasia. The parts most commonly affected are the femora and humeri.

The case reported in this paper was a stillborn infant delivered at term. Antenatal roentgen examination showed stippling of the epiphyses through the hydramnios for which the mother of the infant had been referred late in her pregnancy. The postnatal roentgenograms of the infant showed the sacrum, lumbar and lower thoracic vertebrae consisting almost entirely of opaque dots about 1 mm. in diameter, mostly discrete but in places coalescing. The pelvic bones showed the same stippling, especially in the pubic rami and acetabulum. The alae of the iliac bones were well ossified but the epiphyses of the iliac crests, which normally do not appear until thirteen to fifteen years, were present and stippled. The femora showed stippling at both proximal and distal epiphyses. The left femoral diaphysis was shortened, thickened and bowed, and showed a pseudofracture. The patella and all epiphyses of the tibiae were stippled. The tarsus consisted entirely of calcified spots with little resemblance to the normal anatomy. The scapulae showed stippling only at the inferior angles but the left glenoid was deformed. All the epiphyses of the arm and forearm were stippled. The left humerus, radius and ulna, like the left femur had short, thick diaphyses and the left radius was much bowed. The sternum consisted almost entirely of punctate calcification, and the same appearance was seen in some of the costal cartilages. The hyoid bone and cricoid cartilage were entirely stippled. Faint stippling of the base of the skull appeared to be present.

The histological sections from a femur and costal cartilage showed irregular areas of calcification in the cartilage, often surrounded by smaller discrete calcifying foci. In the costal cartilages there appeared to be patchy mucoid degeneration preceding the calcification. Here the cartilage cells had disappeared and the matrix showed a foamy appearance. Calcified plaques appeared separated by granules of calcified material in the metachromatic-staining stroma. The calcifying areas were in some places invaded by granulation tissue with osteoclastic cells reabsorbing the calcified material. In the femoral epiphysis, however, there were irregular calcified areas in which the cartilage cells were still seen, although their nuclei were undergoing fragmentation. At the periphery groups of calcified cartilage cells were seen with normal cells remaining in between. Evidence of disordered ossification was also shown by clumps of cartilage in the medullary cavity of the shaft of the femur.—*Ralph S. Bromer, M.D.*

TOWNSEND-COLES, W. F. A report of seven cases of chondro-osteo-dystrophy (Morquio's disease). *Arch. Dis. Childhood*, Feb., 1954, *29*, 7–11.

The author reports 7 cases of chondro-osteodystrophy occurring in three sets of siblings in Northern Sudanese families. In each set the parents were close blood relatives. The affected children were said to have been healthy at birth and to have remained so until the seventh or eighth month when deformity became manifest by gradually increasing kyphosis except 1 case in which chest signs were first noticed.

All the patients showed dwarfing and deformity which were more marked the older the child. The normal development of the head made it appear large by comparison with the stunted trunk and limbs, and the excessive shortening of the trunk gave the arms a false appearance of length. The deformities included shortness of the neck, anteroposterior enlargement of the chest, eversion of the costal margin, pointing of the sternum and dorsolumbar kyphosis.

The limb bones were short but enlarged at the ends. The large olecranon process prevented full extension of the elbows and there was ulnar deviation at the wrist joints. Genu valgum and partial flexion of the knee joints were present and the feet were short, wide, flat and everted at the ankle. The milk teeth were well formed but in the 2 oldest living children the permanent teeth were poor in quality.

Roentgenologically, the skull and pituitary fossa were normal. The vertebrae were flat, irregular in shape and texture, poorly calcified and drawn out anteriorly to a point. The anteroposterior diameter of the pelvic brim exceeded the transverse diameter and the acetabular roofs were irregular. The ends of the ribs were abnormally wide. The long bones were thick, short and poorly calcified. The cortices were thin and the cancellous tissue showed coarse and irregular reticulation. The metaphyses were irregular, expanded, and in some cases, cup-shaped. Large irregular epiphyses contained fragmented or multiple ossific centers. Coxa valga and thickness of the femoral necks were associated with flattened femoral heads. The proximal ends of the metacarpals and metatarsals were characteristically conical.—*James F. Martin, M.D.*

Steinbach, Howard L., Kolb, Felix O., and Gilfillan, Rutherford. A mechanism of the production of pseudofractures in osteomalacia (Milkman's syndrome). *Radiology*, March, 1954, *62*, 388–395.

Osteomalacia is a metabolic disease of bone in which there is deficient mineralization of the bony matrix. The defective deposition of calcium salts is due to the lowered concentration of calcium or phosphorus in the body fluids. Because of their decreased mineral content the bones are weakened and bend readily. Deformities of the extremities, pelvis, vertebrae and skull may occur. The osteoblasts are stimulated to lay down new bone matrix and elaborate alkaline phosphatase, which is usually present in abnormal concentrations in the blood serum, but calcium is not available to be deposited in the osteoid.

In some cases of osteomalacia, multiple, symmetrical bands of diminished density, resembling fractures, occur in the cortex of the bone. These pseudofractures, first described by Milkman, are seen most frequently in the scapula, the ribs, the pubic rami, the neck of the femur, the iliac bones and the radii and ulnae. There has been considerable difference of opinion regarding the actual mechanism of the production of these pseudofractures.

The authors present a case of proved osteomalacia with bilateral pseudofractures. Arteriographic studies indicate the presence of arteries in close proximity to some of the pseudofractures. This suggests that the cortical defects are produced by erosion of the softened cortex by the pulsating vessel.—*Arno W. Sommer, M.D.*

Blood and Lymph System

Fuld, H., and Irwin, D. T. Clinical application of portal venography. *Brit. M. J.*, Feb. 6, 1954, *1*, 312–313.

The adequate study of a patient with splenomegaly is an interesting and sometimes puzzling task. Modern advances in vascular surgery make it necessary to recognize those cases of splenomegaly which can be symptomatically helped by vascular anastomosis for relief of portal hypertension.

The method of percutaneous intrasplenic injection was used by the authors on over 50 occasions: 18 cc. of 50 per cent diodone was injected through a flexible lumbar puncture needle with a short bevel, entering through the left posterior axillary line just below the tenth rib with the patient on his back. Usually one roentgenogram made after the injection of 18 cc. was adequate. The material was injected in the peritoneal cavity on several occasions and once into the splenic flexure of the colon. There were no ill effects from this.

Cases are presented demonstrating a normal splenogram, a splenogram in pernicious anemia with splenomegaly, 2 cases of portal hypertension, 1 case of melanoblastoma of the liver, and 1 case of carcinoma of the stomach with secondary deposits in portal fissure causing blocking of the splenic vein.

This method is very useful in the diagnosis of splenomegaly of unknown origin, in the differentiation of intrahepatic and extrahepatic venous block, and in the assessment of the degree of portal hypertension and the anatomy of the anastomosis between the splenic vein and gastric and esophageal vessels. —*Neal F. Yeomans, M.D.*

Iusem, Miguel. Flebografía ascendente en posición erecta. (Ascending phlebography in the erect position.) *Prensa méd. argent.*, Feb. 26, 1954, *41*, 587–591.

In the method described the patient is placed at an approximately 80 degree angle from the horizontal position. The venous puncture is made in the region of the ankle, venous pressure is determined by a manometric method, and a blood pressure cuff is placed above the site of injection with sufficient pressure to prevent reflux of opaque medium into the superficial veins.

Varicose veins, acute thrombosis with characteristic filling defect, chronic thrombosis with filling defect and collateral circulation, and the status of the venous valves may be outlined on the roentgenograms. With this method a more complete anatomic and pathologic picture of the venous system of the lower extremities is obtained, when the method is compared with other methods of venography.—*Charles Nice, M.D.*

Gilfillan, R. S., Jones, O. W., Jr., Roland, S. I., and Wylie, E. J. Arterial occlusions simulating neurological disorders of the lower limbs. *J.A.M.A.*, April 3, 1954, *154*, 1149–1152.

The authors present several instances in which patients with atherosclerotic occlusive disease have been subjected to myelography, pneumoencephalography, leg traction and even laminectomy. They feel that the differential diagnosis of low back, thigh, or gluteal pain should include consideration of arterial occlusion with herniated intervertebral discs, sacroiliac disease, or other abnormality of the low back and hip as a cause of symptoms in this area.

Among the most salient features of arterial occlusive disease is the onset of pain and its rapid increase in close proportion to the amount of muscular exercise to the affected area. Another distinguishing feature is the rapid regression of pain on cessation of the muscular effort that brought it about. The pain of claudication subsides in seconds or minutes, while nerve pressure pain or musculo-skeletal disorders aggravated by exercise subside very slowly and often last hours beyond the aggravating effort. Terminal aortic, total iliac, partial iliac and femoral profunda

obstructions as well as superficial femoral or femoral popliteal occlusions are all well defined syndromes.

With arterial occlusion there is absence of peripheral pulses, although even in terminal aortic occlusion very weak femoral pulsations may occasionally be felt. A cool pale foot, dependent rubor, a decreased or reduced oscillometric recording in the thigh and calf, and the conclusive evidence of obstruction seen in an aortogram displaying the major lower aortic and extremity circulation usually suffice to make the diagnosis of arterial occlusive disease.—*Arthur E. Childe, M.D.*

GENERAL

LICHTENSTEIN, BEN W. Sturge-Weber-Dimitri syndrome; cephalic form of neurocutaneous hemangiomatosis. *A.M.A. Arch. Neurol. & Psychiat.*, March, 1954, *71*, 291–301.

The author presents 3 cases with more or less typical histories, clinical features, roentgen findings, and gross and microscopic changes in the brain and meninges.

The clinical features include angiomas of the face and scalp with signs of cerebral dysfunction such as mental deficiency, epilepsy or hemiplegia. Skull roentgenograms usually show fine tortuous shadows of calcium density along the surface of the brain.

The hemangiomas are confined to the leptomeninges but may occasionally extend into the cortex or even into the medullary portion of the brain. The cortex may show a complete absence of nerve cells with extensive gliosis. Calcium or iron concretions are found about the capillaries and on the brain surface.

The author suggests that the changes in the cortex are due to alterations in metabolism induced by venous stasis. If the disturbances in metabolism occur early there may be a complete absence of nerve cells and little or no calcification.

The double contour radiopaque lines are again described as outlining the cerebral convolutions rather than actually being calcified blood vessels. The article should be read in full to follow the author's line of reasoning.—*Frank M. Windrow, M.D.*

LATHAM, W. J. Hydatid disease. Part I. *J. Faculty of Radiologists*, July, 1953, *5*, 65–81.

Hydatid disease is pre-eminently associated with sheep and dogs; it is most prevalent where the sheep-rearing population lives close to its dogs and is ignorant of the disease. The echinococcus, which is responsible for hydatid disease in man is a cestode of the Taenia family. It produces three quite distinct types of disease:

1. Benign unilocular type.
2. Osseous type.
3. Malignant alveolar type.

The adult echinococcus lives usually in very large numbers attached to, and secure between, the folds of the small intestine of the dog, which is the definitive host. When fully grown the echinococcus is minute, seldom much longer than 5 mm. It has a head or scolex, equipped with both suckers and hooklets, in addition to a short neck and four proglottides. The terminal proglottid is usually gravid and filled with an enormous number of eggs. After separating from the worm, this proglottid ruptures just before or just after its evacuation from the dog's intestine. The eggs may be transferred to the human alimentary canal by way of uncooked foods or by contaminated fingers. The eggs hatch readily in the small intestine, and the six-spined embryo soon burrows into the human mucosa until it strikes the mesenteric venous system. Here it moves through the blood stream until it reaches a point beyond which it is too large to pass, and there it lodges. Hence, 70 per cent of human lesions are found in the liver and about 12 per cent in the lung. Almost any other organ in the body may be the site of involvement. If the embryo survives it stimulates a foreign body type of reaction, becoming surrounded by mononuclear cells, replaced after three days by eosinophile and endothelial cells. In two more weeks it vesiculates, the cytoplasm undergoes hyaline changes and fluid forms in the center. The future of the cyst and its relationship with its host depend largely upon its site. If it is in a roomy location, such as liver, lung or peritoneum, it will develop into the common form of unilocular hydatid cyst. This is composed of a two-layered laminated wall. The inner wall is germinal, contains cyst fluid, and produces the brood capsules from the adventitia which is the protective layer provided by the host. A cyst, while still healthy, does not contain daughter cysts. Development of daughter cysts is apparently a defense mechanism when the viability of the original cyst is threatened, as by trauma. This mechanism consists of the cyst breaking itself up into numerous self-contained daughter and granddaughter cysts, still within the original adventitia. Calcification is a common ending for a hydatid, which at this stage is either dead or quiescent and harmless.

In the osseous type because of the confines of the bone, the cyst progresses ameba-like along the bony medulla, without development of a limiting adventitia. Eventually the cortex may be destroyed and pathological fracture may result. Having broken through the cortex and periosteum, the process accelerates, but the muscles endeavor to encyst it, and an adventitia is then formed.

In the malignant alveolar type apparently the germinal layer is not intact and this allows exogenous budding associated with an ameba-like spread along the tissue planes. The adjacent glands become involved as well as distant blood-borne metastases, and the outcome is slowly but finally fatal.

Medical and radiation therapy are not effective. Surgery is the only solution to curing the disease.

The Diagnostic Roentgenological Aspects of Echinococcus Infection. The major portion of hydatid involvement is in the abdomen. Fifty-seven to 74 per cent of lesions are found in the liver, 1.3 to 18.2 per cent in the peritoneum, and 1.2 to 9.0 per cent in the spleen.

In the liver, there may occur: (1) unruptured cysts, which may be calcified or uncalcified; (2) infected cysts; (3) ruptured cysts, emptying (a) through the diaphragm into the pleural cavity and bronchial tree, (b) through the bile passages into the duodenum, (c) elsewhere into the intestinal tract, or (d) into the peritoneal cavity.

Unruptured calcified cysts are usually spherical, often multiple, varyiug in size from a quarter dollar to two inches or more in diameter, and with their calcium content reticulated in appearance. Calcified renal hydatid, gallstones, calcified gallbladder, pancreatic, adrenal and mesenteric calcification, and calcified costal cartilage must be considered in differential diagnosis.

In the case of an uncalcified and unruptured cyst, its presence may be suspected in the roentgenogram by displacement of adjacent viscera, if the cyst is growing from the lower edge of the liver. It may enlarge upward producing elevation of the dome of the diaphragm, nearly always the right leaflet, and usually anteriorly. Movements of the right hemidiaphragm are usually restricted and the cyst may be seen in relief after a diagnostic pneumoperitoneum, projecting from the upper surface of the liver. In differential diagnosis one must consider subphrenic abscess, amebic abscess, carcinoma, syphilis and tumors.

In infected cysts when not calcified, their presence may be postulated from signs as just noted in the uncalcified and unruptured cysts. In addition, in the liver, air very rarely, after rupture through the diaphragm, gets into the cyst. This produces collapse of the cyst wall and gives the sign of the "Camelotte"—the appearance of the crumbled, collapsed, and deflated cyst wall floating in a heap upon the remaining cyst fluid. Also, the infected cyst usually produces either a small pleural effusion or a pneumonitis in the lung adjacent to the diaphragm.

Cysts may rupture into the bile passages, with accompanying evidence of a non-functioning gallbladder on cholecystography. They may rupture into the intestinal tract and pieces of hydatid membrane may then be found in the stools. The cysts may rupture into the peritoneal cavity with escape of hydatid fluid giving toxic or anaphylactic reactions, with hemorrhage from vessels in the pericyst, with heterotopic cyst formation from extrusion of the whole mother cyst, with escape of scolices producing multiple secondary peritoneal cysts, with formation of pseudotuberculous nodules scattered over the peritoneum, with escape of bile into the peritoneal cavity, and/or with a choleperitoneum type of reaction without bile contamination. Roentgen examination is of little or no value in diagnosis where a cyst has ruptured.

Hydatid cysts in the lungs may be primary or secondary, single or multiple, and peripheral or hilar in location. Many cases of lung hydatids are multiple. They appear anywhere in the lung fields, are usually spherical in shape, and have the roentgen appearance of any cyst. They may vary from the size of a small coin, to that of a cyst obliterating an entire lung. The single, simple cyst must be differentiated from other solitary spherical intrathoracic masses. The Ecudero-Nemenov sign implies that a cystic lung mass may be seen on fluoroscopy to change its shape during respiration, while no such change is seen in solid tumors. This merely establishes the lesion as cystic in nature.

Rupture of a hydatid lung cyst may result in hydro- or pyo-pneumothorax and/or secondary multiple pleural echinococcus. If the adventitia communicates with the bronchial tree, air is able to get between it and the ectocyst, producing the *sign of detachment.* It is best seen in roentgenograms taken in deep inspiration. It normally heralds the disintegration and eventual expectoration of the cyst.

The *double arc or cumbo sign* is brought about by damage to the adventitia and the hydatid membranes, giving a crescentic air image. Before total expectoration of the cyst takes place, the stage of the double arc sign occurs, representing the stage when, some of the hydatid fluid having been expectorated, there is an air-fluid level within the cyst itself, as well as the air cap between the hydatid membranes and the host's adventitia. The *sign of the camelotte* previously described in the discussion on hydatid cyst of the liver represents still another stage in the disintegration of the cyst.

In addition to the above findings, a lung hydatid may rarely show evidence of calcification.

There are three maxims which, although strictly outside the field of diagnostic roentgenology, should always be remembered:

1. Do not aspirate a hydatid (possibly excusable when situated in bone).
2. Do not perform a diagnostic pneumothorax if there is any possibility of a mass under observation being a subpleural hydatid.
3. Do not perform formolage on a lung hydatid (formolage, which was introduced by Dévé, is the aspiration of the cyst fluid and its replacement by 2 per cent formalin).

The cyst often ruptures subsequently, thereby producing a formalin aspiration bronchopneumonia. Remember that a hydatid is normally under 300 mm. of water pressure and is very prone to burst, especially if pricked.—*Samuel G. Henderson, M.D.*

RADIATION THERAPY

WINDEYER, B. W. Radiotherapy in its relation to dermatology. *Brit. M. J.*, April 24, 1954, *1*, 945–949.

The author reviews the history and use of radiotherapy in the treatment of dermatological conditions both benign and malignant since the epoch making discoveries of Röntgen and Becquerel. The discussion of the treatment techniques utilized in various disease entities, together with salient indications, contraindications and sequelae, is concise and informative.

He closes with a plea for mutual understanding and collaboration between radiologist and dermatologist toward the end that the full potential of our radiologic armamentarium may be realized.—*Geno DiBagno, M.D.*

KNOLL, V. Die Epilationsdosis (The epilation dose.) *Strahlentherapie*, 1954, *93*, 299–306.

From the experience of approximately 30,000 epilations, the epilation dose of 300 r (with hvl. of 1.1–1.25 mm. Al and a f.s.d. of 25 cm.) per field was reduced to 260 r per field because the larger dose yielded occasional permanent epilation at the parietal eminences.

The standard five field method was further modified by altering the angulations of the tube as follows:

For the frontal field, the tube is angled 15–20° cephalad. The central beam still strikes the head at approximately the hair line, and must not strike the head closer than 15 cm. from the center of the vertical field.

The vertical field is unaltered from the conventional method.

The occipital field requires that the central ray be directed cephalad about 15–20° also. Its center must be at least 15 cm. from that of the vertical field. For most children, this means that the central beam strikes the head at approximately the posterior hair line.

For the two lateral fields, the central beam is directed approximately 30° toward the vertex (as opposed to the conventional method of making the central beam and the temporal plane of the head parallel). The point of entrance remains the temporal region.

The purpose of these changes is angulation is to decrease the dose from overlapping of fields at the parietal eminences (especially in young children and in children with relatively small heads) and to render the overall dose to the scalp more nearly homogeneous.

This method was employed in treating almost 20,000 (after 10,000 had been treated by the conventional five field method) children in Iran with uniform epilation, no permanent epilation and no evidence of cerebral damage.—*Henry G. Moehring, M.D.*

BERKMAN, A. TEVFIK. Progressive exophthalmos following thyroidectomy cured by irradiation of the cerebral centers; a case report. *Radiology*, March, 1954, *62*, 406–408.

The author describes his successful result in treating a patient with exophthalmos, which had continued to progress after thyroidectomy for Graves' disease. He irradiated the hypophyseal-hypothalamic region employing three portals (two temporal and one frontal) measuring 4 by 4 cm. each. The irradiation factors used were 200 kv. p., 15 ma., 2.0 mm. Cu plus 1.0 mm. Al filtration, 1.8 mm. Cu half-value layer. The focus-skin distance was 50 cm., and the dose was 800 r per portal in forty-nine days, each portal being treated once a week. There was not only marked improvement of the exophthalmos, but also disappearance of the insomnia, abdominal pain, and tremor, which had been present.

He feels that irradiation of the pituitary should be the method of choice in treatment of these patients, pointing out the usually disappointing results that have been obtained with medical and surgical measures. The rapid correction of the exophthalmos is probably produced by a reduction of the retrobulbar mesenchymal reaction. He presumes that the other symptoms are relieved by a re-establishment of the synergy between the hypophysis and subthalamus.—*Charles L. Stevenson, M.D.*

JACOBSSON, FOLKE. Treatment of carcinoma of the thyroid. *Acta. radiol.*, Feb., 1954, *41*, 169–191.

One hundred and forty-four consecutive cases of thyroid carcinoma, treated at Radiumhemmet from 1935 to 1946 were reviewed with special attention to: (1) the results of treatment in relation to the extent of the disease and the histopathological appearance of the tissue; (2) the value of radiation therapy and especially teleradium; and (3) the treatment of choice.

The cases were classified into six groups: (1) highly differentiated adenocarcinoma—8 per cent of the cases; (2) well differentiated papillary adenocarcinoma—14 per cent of the cases; (3) moderately well differentiated adenocarcinoma—34 per of the cases; (4) slightly differentiated adenocarcinoma (small cell type)—22 per cent of the cases; (5) giant cell carcinoma—3 per cent of the cases; and (6) undifferentiated carcinoma—12 per cent of the cases. In 7 per cent of the cases the histopathological material was not adequate to be classified.

Three-fourths of the cases were inoperable and received teleradium therapy as a sole method of treatment. The remaining one-fourth of the cases

were operated on and subsequently received teleradium irradiation.

Radium treatment with a 3 or 5 gram source was given at a radium-skin distance of 6 cm. The treatment field was 5 cm. in diameter and three or more fields were used, depending on the size and extent of the tumor. The dose was raised to skin tolerance. A direct skin dose of 4,000 r_γ to 5,500 r_γ was administered to each field, depending on the number of fields and the distance between centers. Daily skin doses of 1,000 r_γ were used. Ordinarily one series of treatments was given, but occasionally two or more were given. The advantages of the radium irradiation were that there was a large skin dose and consequently a higher tumor dose, there was less reaction in the trachea and esophagus, and the risk of cartilage necrosis was less.

The overall five year survival was found to be 46 per cent. The operable cases had a 95 per cent five year survival, and the inoperable cases without distant metastases had a 35 per cent survival. The results in the operable cases were somewhat independent of the histopathologic type of the tumor. The results of treatment in the inoperable cases without metastases were good in the papillary adenocarcinoma, fair in the highly differentiated adenocarcinoma, and unsatisfactory in the slightly differentiated adenocarcinoma and undifferentiated carcinoma. The latter were usually extremely malignant and had metastasized in the majority of cases when first seen. The results were quite good in the inoperable moderately differentiated adenocarcinoma and this was thought to be due to the intensive teleradium therapy.

Highly differentiated adenocarcinomas usually were retarded in growth by treatment and sometimes reduced in size. The slightly differentiated adenocarcinomas were markedly radiosensitive in about half of the cases. The undifferentiated carcinomas were extremely malignant and metastasized early.

A good general discussion of carcinoma of the thyroid is given and it is emphasized that all nodular thyroids should be removed in order to detect early malignancy. Mobile lymph nodes are no contraindication to operation. However, carcinoma of the thyroid except for the papillary type seldom involves the lymph nodes unless it has penetrated through the capsule.

Postoperative irradition is now recommended quite generally, and this is based on the improved survival rates. Roentgen treatment is favored widely, however the author believes that it is difficult to obtain a cancerocidal dose without affecting the normal tissues and the patient's general condition. Treatment with radioactive iodine is also discussed; the author used it in only one case which resulted in some relief of pain from skeletal metastases.

It is concluded that the treatment of choice in thyroid carcinoma is surgical removal of the growth in operable cases and postoperative irradiation with teleradium. The inoperable cases should be treated by irradiation with teleradium.—*Charles W. Cooley, M.D.*

Bordley, John E. Recent observations on the use of nasopharyngeal irradiation for the control of hearing impairment in children. *South. M. J.*, March, 1954, *47*, 246–249.

A five year study of 5,000 Baltimore school children with respect to hearing impairment associated with upper respiratory tract lymphoid tissue was completed in 1953. Approximately 500 of these children whose average age was eight years on initial examination were selected by audiometric screening tests and placed in a study group. This group was then divided by random selection into a treatment and a control group. All children in each group were given three treatments at two week intervals with the standard monel metal nasopharyngeal radium applicators, the radium having been removed from the applicators used on the control group. The five year follow-up consisted of complete ear, nose and throat examinations at six month intervals, and included nasopharyngoscopy and audiograms.

The initial conclusions reveal that a marked reduction in lymphoid tissue takes place following irradiation, and severe conductive hearing loss is improved. No instance of trauma from irradiation has been encountered. The technique is not advised for removal of large central lymphoid masses, or for treatment of deafness other than that of the conductive type due to recurrent otitis media and eustacian tube occlusion.—*Arch H. Hall, M.D.*

Evans, John C., and Ackerman, Lauren V. Irradiated and obstructed submaxillary salivary glands simulating cervical lymph node metastasis. *Radiology*, April, 1954, *62*, 550–555.

Irradiation of the submaxillary gland and obstruction of Wharton's duct produce fibrosis of the gland. A discrete, firm mass, consisting chiefly of atrophy, fibrosis and inflammation, may result. Such a mass may be confused with metastases in cervical lymph nodes.

The authors studied 20 patients with primary lesions of the oral cavity treated variously by surgery, interstitial radon or radium application, and external roentgen irradiation. Twelve of the 20 cases showed no metastatic tumor in the cervical lymph nodes. All showed changes in the submaxillary gland, consisting chiefly of atrophy, fibrosis, and inflammation. Characteristic alterations are enumerated by which late irradiation damage can be differentiated from the effect of Wharton's duct obstruction.

A careful appraisal of the clinical and radiotherapeutic data in each case, and the use of needle biopsy, may aid in making the correct diagnosis and obviate unnecessary radical surgery.—*Arno W. Sommer, M.D.*

Birkner, Rudolf, and Schaaf, Johannes. Neun Fälle von Strahlenschädigungen der knorplig-knöchernen Brustwand. In einem Fall tödlicher Ausgang. (Nine cases of radiation damage to the osseous and cartilaginous thoracic wall. One fatal case.) *Strahlentherapie*, 1954, *93*, 454–465.

Nine cases of radiation damage to the cartilaginous or osseous portions of the anterior thoracic wall are described in some detail. Radiation was administered for either extra- or intrathoracic tumors. In 1 case the damage was severe enough to cause death via retrosternal abscess and purulent pericarditis.

Dosages to the damaged areas ranged from 6,450–20,000 r of roentgen rays of various qualities. The authors have calculated a "bone-effective" dose to compensate for the various qualities of radiation used; e.g., they have mutiplied the depth dose from a beam with hvl. of 0.8 mm. Cu by a factor of 3 and the depth dose from a beam with a hvl. of 0.14 mm. Cu and a focal-skin distance of 5 cm. by a factor of 5.5. These "bone-effective" doses varied from 18,000–520,00 [rep]. The time interval between irradiation and the appearance of the radiation damage varied inversely with the "bone-effective" dose. In 2 cases radiation damage appeared in approximately ten years after 18,000 and 21,000 [rep] had been administered, while only 1½ years elapsed before the damage from 42,000 [rep] (and ½ year for 52,000 [rep]) appeared.—*Henry G. Moehring, M.D.*

Rosselli, Emilio César. Roentgenterapia en la tuberculosis anexo-peritoneal. (Roentgen therapy in adnexal tuberculosis.) *Radiología*, Argentina, 1953, *14*, 60–72.

Following a rather extensive discussion of historical and clinical findings in adnexal tuberculosis the case for using radiation therapy in this condition is expounded.

Two fields, anterior and posterior, are used with factors of 180–200 kv., 6–10 ma., and a filter of 0.5 mm. of copper. A dose of 50–80 r per field weekly or every two weeks up to a total of 240–320 r may be given. Exceptionally, a total dose of 400–450 r is given in some cases.

The statistics are based on 114 cases which have been observed from six months to sixteen years. Eighty per cent of the cases had a single series, 15 per cent had two series and 5 per cent had three series maximum. It was considered that 80.2 per cent were cured, 9.9 per cent were improved, 6.9 per cent doubtful and 3 per cent poor results.

Before initiating radiation therapy it is suggested that a roentgenographic examination of the lung and intestines be done. Active tuberculosis, especially the pulmonary form, seems to be a contraindication to the use of radiation therapy in this condition.—*Charles Nice, M.D.*

Muller, H. J. Damage to posterity caused by irradiation of the gonads. *Am. J. Obst. & Gynec.*, March, 1954, *67*, 467–483.

Geneticists believe that the gene is the basis of life and that it controls all processes of the organism.

The author used the fruit fly (*Drosophila*) in his experiments because many generations can be obtained in a short time, breeding can be controlled, and the variations in numerous characteristics can be distinguished.

A common misconception among nongeneticists concerning mutations is that they are responsible for gross abnormalities such as circus freaks or monsters. The fact is that for each such mutation, there are hundreds with effects too small (or hidden) to be noticed.

In general, a mutant gene is received from one of the parents so that it is heterozygous. The corresponding normal gene from the other parent is usually dominant and thus exerts more influence in determining the characteristics of the individual. In subsequent transmission, two individuals heterozygous for the same mutant gene may mate and produce a child homozygous for the mutant gene. The effects here are more pronounced but they may still be too small (or hidden) to be recognized. This rarely happens, however, since the heterozygous gene has little chance to meet its like in the general population and the line of individuals transmitting it usually dies off before this occurs due to the detrimental effects of the mutant gene. This appears to be paradox, but it must be remembered that individuals differ from one another largely by their differing mutant genes, otherwise, each would be an identical twin of the other.

The fully lethal mutation that kills the first individual would appear to be the worst mutation, but those which do any damage at all are equally harmful since their lesser effect is compensated for by the greater number of individuals affected.

There is no threshold dose as far as mutations in human germ cells are concerned. All doses, no matter how small, carry risk proportional to their size. Also, the number of mutations is greater at the oogonium and spermatogonium stages of germinal development.

Workers have shown that the induced mutational effects are greater in mammals than in the fruit fly. Thus, the use of fruit flies has actually underestimated the amount of mutational change in man.

The frequency of naturally occurring mutations in man is estimated at one mutation in 50,000 genes. By comparing statistics of induced mutations in mice and converting to man, it is estimated that 85 r would double the mutational frequency. The author presents a hypothetical case of a woman treated for sterility, with a dose of 255 r to the ovaries, who subsequently bore two children. He estimates that one of the children would carry a newly induced

mutation. This would probably cause no immediately recognizable effect, but the detrimental mutant gene would be multiplied from generation to generation until it caused the extinction of the line. —*G. J. DiBagno, M.D.*

Kaplan, Ira I. Third generation follow-up of women treated by x-ray therapy for menstrual dysfunction and sterility twenty-eight years ago, with detailed histories of the grandchildren born to these women. *Am. J. Obst. & Gynec.*, March, 1954, *67*, 484–490.

In a twenty-eight year period the author treated 660 women for infertility by means of low dosage roentgen therapy to the ovaries and pituitary gland. Of 441 of these patients, subsequently followed, 270 became pregnant one or more times with 347 deliveries of apparently normal children. Definite failure of treatment was recorded in 107 cases; 67 were not successful for various reasons not directly related to treatment. The incidence of miscarriage was no higher than for nonirradiated pregnancies.

Although the concept of ovarian "stimulation" as the rationale for such treatment is no longer held, the author is unable to explain the favorable results reported. The clinical demonstration is considered convincing evidence of the efficacy of this treatment.

Objections to roentgen therapy directed to functioning ovaries usually center around possible genetic effects on future progeny of these irradiated women. The author traced second and third generation offspring of the originally irradiated group and did not find a significant number of abnormalities. Fourteen grandchildren are reported, derived from the orginal group of irradiated patients, without evidence of genetic abnormality. Brief case histories of the families of the earliest women treated for sterility are included.—*J. Maurice Swain, M.D.*

Fochem, K. Die Wirkung der Laevulose bei der Strahlenkrankheit. (The effect of levulose in radiation sickness.) *Strahlentherapie*, 1954, *93*, 466–472.

Bromsulphalein tests show considerable parenchymatous hepatic damage during irradiation. The imparied hepatic function persists for approximately three weeks. Orally administered levulose exerts a protective, or detoxifying, action so that the impairment of hepatic function during irradiation is considerably decreased, and even prevented.—*Henry G. Moehring, M.D.*

Kutzim, H., and Klesse, P. Die Anlage für Teleradiumtherapie mit 10 g Radium in den Kölner Universitätskliniken. (The arrangement for teleradium therapy with 10 grams of radium in the University Clinics of Cologne.) *Strahlentherapie*, 1954, *93*, 389–394.

The arrangement of a 10 gram radium cannon for teleradium therapy is described in some detail. The dosage rate varies from 1,000–1,710 r/hour dependent on the filters and cones used. Depth dose curves established in water phantoms and isodose curves depicting evaluation of radiation protective measures are reproduced. Distribution of radiation in the body was measured in some more important instances in cadavers.—*Henry G. Moehring, M.D.*

Grimmett, Leonard G., Fletcher, Gilbert H., and Moore, E. B. An improved light localizer for x-ray therapy. *Radiology*, April, 1954, *62*, 589–593.

The authors describe a new type of light localizer for delineating roentgen therapy fields. It incorporates several new features, which are as follows: (1) a simple optical system for showing the penumbra of the roentgen-ray beam; (2) a system of interconnected lead diaphragms permitting a wide choice of fields of different sizes, all symmetrical about the central axis of the roentgen-ray beam; (3) provision for insertion of wedge filters and for their orientation in any desired direction; (4) a detachable holder for rapid centering of a condenser chamber for calibration.

The component parts of this new light localizer as well as details of their construction and advantages are discussed.—*Michael J. Healy, M.D.*

RADIOISOTOPES

Harvey, Roger A. Observations in atomic medicine. The Carman Lecture. *Radiology*, April, 1954, *62*, 479–487.

There has been a rapid accumulation of data regarding radioactive isotopes. With the increase in knowledge and experience has come a more sensible and rational evaluation of the place of radioactive substances in diagnosis and therapy. They are no longer regarded as an immediate answer to the cancer problem. Their greatest usefulness is in the fields of diagnostic tests and laboratory investigations.

Iodine^{131} has built up a tremendous usefulness in analyzing functional activities of the thyroid and making clear the relation of some of these states to pituitary influence. I^{131} uptake studies have been used to supplement, and in many instances to replace, basal metabolic rate determinations. Thyroid surgery has decreased but surgery is still the method of choice in the treatment of most nodular goiters and of noniodine-absorbing neoplasms. Somewhere between 80 and 90 per cent of thyroid cancers fall into this group.

P^{32} was the earliest and probably most widely used radioactive isotope. Its therapeutic use is now largely confined to polycythemia (rubra) vera and certain forms of leukemia. It appears to be the treatment of choice in polycythemia. Au^{198} has contributed moder-

ately to palliative therapy in advanced cancer where effusion or ascites is troublesome. It is being used in the treatment of carcinoma of the prostate, and reports of results seem promising. Co^{60} and closely related emitters have the advantage of high output, flexibility and maneuverability and relatively low cost. They will undoubtedly enjoy much wider application than radium bombs ever did. The most important use of radioactive isotopes has been and will continue to be in fundamental biology, biochemistry, and physiology. Tracer studies have made valuable contributions to a better understanding of body processes in health and disease.

The present problem of evaluation of supervoltage machines is chiefly one of accumulating adequate clinical experience. The very high energy super voltage machines do permit a more specific or controlled pattern of distribution of radiation in the body. They have stimulated a great deal of research which has increased our appreciation of absorption, intensity and dosage. Their real contribution lies in the ability to deliver more radiation to the desired zone while keeping normal tissue absorption lower than with conventional therapy machines. This more specific delivery of dosages has brought about an improvement in results in certain brain tumors, lung tumors and cancer of the esophagus.—*Arno W. Sommer, M.D.*

GOLDSMITH, RICHARD. Experience with the radioiodine tracer test in radioiodine-treated thyrotoxic patients. *Am. J. M. Sc.*, April, 1954, *227*, 403–407.

The problems concerned with determining the types of thyrotoxicosis which will respond to a given form of therapy and with deciding when a treated disease is under control are discussed by the author. Forty-five unselected thyrotoxic patients who had been previously treated with I^{131} underwent I^{131} tracer studies. Group A were clinically thyrotoxic, group B were clinically euthyroid and group C were clinically myxedematous by clinical evaluation and frequent basal metabolic rate examinations. According to the author, the I^{131} 24 hour uptake ranges are: thyrotoxic—above 60 per cent; borderline—50–60 per cent; euthyroid—20–50 per cent; and myxedematous—0–38 per cent. Pre-therapy and post-therapy 24 hour per cent I^{131} uptake and 48 hour per cent urinary excretion studies are tabulated. The interval between therapy and tracer studies ranged in group A from 2 to 19 months, in group B from 2 to 36 months, and in group C from 5 to 48 months. Two patients in group A and 11 patients in group B had two courses of therapy and 1 patient in group B had three courses of therapy. The amount of I^{131} administered therapeutically is not given. Of the 19 studies on 12 patients in group A, 12 were in the thyrotoxic range and 5 were significantly lower than prior to treatment. Of the 40 studies on 31 patients in group B, 22 were in the euthyroid range, 2 were in the thyrotoxic range, and 11 were in the myxedema range. The latter could also be interpreted as indicating a chemical block. Group C were myxedematous. Urinary excretion studies were not as consistent as were the I^{131} studies.

The author concludes that a high 24 hour uptake following therapy for thyrotoxicosis indicates persistence of the thyrotoxic state while a low uptake suggests the patient is no longer thyrotoxic. A normal uptake cannot be interpreted. The reluctance of many clinicians to the use of I^{131} therapy for toxic nodular goiter on the basis of high dosage necessary may be due to the decreased iodide-accumulating capacity of the treated gland. The tracer study is valid following I^{131} therapy only when the uptake is elevated.—*George Roberts, M.D.*

DUNBAR, HOWARD S., and RAY, BRONSON S. Localization of brain tumors and other intracranial lesions with radioactive iodinated human serum albumin. *Surg., Gynec. & Obst.*, April, 1954, *98*, 433–436.

One hundred consecutive patients with suspected intracranial lesions were studied using external counting to determine selective localization of radioactive iodinated human serum albumin. All patients were examined, and conclusions drawn, before any other diagnostic procedures were carried out, to eliminate bias in the interpretation of the isotope data. With these very strict criteria, the authors obtained a correct prediction in 76 patients. While not as high a percentage as has been reported by several other authors, this would appear more realistic, and still leaves the method a useful adjunct to the diagnosis of some intracranial lesions.

The order of accuracy was high for neoplasms of the cerebral hemispheres, and for subdural hematomas. The procedure was of questionable value for small lesions about the base and midline. Of 47 patients subsequently shown to have no focal lesion, 45 were diagnosed correctly by the isotope method.—*R. Kenneth Loeffler, M.D.*

SHIPLEY, REGINALD A., and MACINTYRE, FRANK H. Effect of stress, TSH and ACTH on the level of hormonal I^{131} of serum. *J. Clin. Endocrinol. & Metabol.*, March, 1954, *14*, 309–317.

To study the behavior of the thyroid gland in conditions of stress, 9 patients who were to have major surgery received 100 microcuries of I^{131} forty-eight hours prior to operation. Its activity in the butanol-soluble (thyroxine) fraction of serum was determined 24, 48, 72 and 96 hours thereafter, *i.e.*, two days before and after surgery. Ten patients with minor skin disorders and inactive asthma served as controls. In addition 9 patients were given 12–15 mg. of TSH

forty-eight hours after the administration of I^{131} and 9 others received ACTH; in all of them the butanol-soluble fraction of serum I^{131} activity was checked at the same intervals as in the surgical cases. Counts over the thyroid area were also taken; in the patients who received TSH as well as in some surgical cases protein bound I^{131} was measured.

It was found that the control cases and those who received ACTH showed no I^{131} activity increase in the butanol-soluble fraction of serum, 24 and 48 hours after the administration of I^{131}. In 3 out of the 9 surgical cases and in 5 of the 9 receiving TSH an increase could be detected. This increase was never as high as that encountered in hyperthyroidism. Where protein bound I^{131} measurements were made they paralleled the rise in butanol activity. The external count over the thyroid area, in patients who received TSH, showed an upward trend during the first 48 hours, as should be expected; at 72 hours this trend was reversed; at 96 hours the changes were completely erratic.

It is known from animal experimentation that the peripheral utilization of thyroid hormone is increased during stress. This suggests that the release of thyroid hormone from the gland in acute stress is a compensatory mechanism. But the rise in the level of hormonal I^{131} of serum in some of the surgical cases might indicate a direct stimulation of the gland, if it is assumed that the absolute level of serum thyroxine had been elevated along with that of I^{131} activity. Since, from the results in the control cases, it seems that an equilibrium between I^{131} in serum and thyroid had been obtained in 48 hours, this assumption may be justified. The failure of 6 surgical cases to show a rise of I^{131} activity may be explained on the basis of accelerated peripheral disposal of hormone or postulating that the stimulus had not been strong enough to provoke release of hormone.—*F. Comas, M.D.*

Reilly, William A., French, Richard M., Lau, Francis Y. K., Scott, Kenneth G., and White, William E. Whole blood volume determined by radiochromium-tagged red cells; comparative studies on normal and congestive heart failure patients. *Circulation*, April, 1954, *9*, 571–580.

Although red blood cell volume determinations utilizing cells labeled with radiophosphorus, iron, and chromium are stated to be the same, it is the contention of the authors that Cr^{51} is superior because of its physical properties and ease of application. The radioiron method requires donor RBC and therefore is not as efficacious as the other methods. Because P^{32} is a beta emitter, its radiation effect is greater than Cr^{51} which emits mainly gamma radiation. In addition the Cr^{51} tag is more stable and is constant for at least twenty-four hours as opposed to only about sixty minutes for P^{32}.

A blood sample is drawn, tagged with chromium 51, injected, and then total counts/sec./cc. injected are compared to counts/sec./cc. withdrawn. The degree of dilution indicates the patient's blood volume.

Whole blood volume in normal patients ranged from 2,500 to 6,084 cc. Successive counts on each of 17 patients varied from 0.4 per cent to 10 per cent. Additional studies were performed on patients without signs or symptoms of congestive failure but who who were known to have cardiac disease; on patients who had had congestive failure but were then compensated; and on groups of patients with present symptoms of dyspnea, orthopnea, ascites, hydrothorax, peripheral edema, or combinations of these findings.

It is concluded that patients having normal cardiac function have whole blood volumes of 65.5 ± 5.95 cc. per kg. body weight or 2.49 ± 0.28 liter per square meter body surface area. Increased blood volume is observed in patients with right ventricular failure, but not with left ventricular insufficiency or mitral stenosis alone.—*George Roberts, M.D.*

MISCELLANEOUS

Tobias, Cornelius A. Remarks on the radiosensitivity of unicellular organisms. *Acta radiol.*, Jan., 1954, *41*, 105–108.

The mechanism of radiation effects as shown by the inhibition of cell division in haploid and diploid *Saccharomyces cerevisiae* can be accounted for quantitatively on the assumption that the lethal action is genetic in nature and that injury can occur at any one of a number of "essential genetic sites" (provisionally estimated at 25 ± 15). The probability of inactivation appears about equal for all sites but inhibition of diploid cells requires the inactivation of a pair of sites so that generally more than one particle must cross the cell. Thus, diploid cells are about five times more resistant than haploid cells although higher ploidy is accompanied by increased sensitivity.

In a large proportion of cases, the radiation acts indirectly through intermediate chemical substances and not by the direct passage of particles through the sensitive sites which are associated with biological processes essential to cell division.

Colonies grown from irradiated diploids may have recessive damage which appears as an inheritable increased radiosensitivity. Also the radiation resistance depends on the state of cell division.

Cells grown from different sources vary in sensitivity to some extent so that it should be possible to isolate genes linked to radiation sensitivity.

The radiations used covered a range of specific ionization from 6×10^6 ev/g. cm.^{2} (high energy deuterons and roentgen rays) to 2×10^9 ev/g. cm.^{2} (low energy alphas).—*Raymond Quick, B.S.*

ANDERSON, ELDA E. Education and training of health physicists. *Radiology*, Jan., 1954, *62*, 83–87.

The constantly expanding atomic energy program, the increased use of radioactive isotopes, the new problems in civil and military defense, in industrial hygiene and in environmental health, have increased the demand for trained health physicists. It is their responsibility to detect, to control and to protect against radiation hazards.

The degree of training needed by the health physicist depends on the nature and magnitude of the operations involved. Periods of training range all the way from a few weeks on-the-job training to a highly integrated training equivalent to a course leading to a Ph. D. with post-doctoral training.

This wide range of training personnel can be divided into three groups: (1) The surveyor who does the routine health physics tasks, and must have an empirical command of the science behind his methods; (2) the junior health physicist, who is responsible for radiation control and monitoring beyond the routine stage; and (3) the specialist and senior health physicist who is responsible for the overall radiation safety program in a large plant.

An active training program is being carried out at Oak Ridge National Laboratory and at Vanderbilt University–Oak Ridge National Laboratory as well as at Rochester, New York, and Brookhaven.—*Arno W. Sommer, M.D.*

MARINELLI, L. D., NORRIS, W. P., GUSTAFSON, P. F., and SPECKMAN, T. W. Transport of radium sulfate from the lung and its elimination from the human body following single accidental exposures. *Radiology*, Dec., 1953, *61*, 903–915.

This is the first study of acute inhalation exposure to an insoluble salt of radium in contrast to other reports of chronic exposure to soluble salts, given intravenously.

Six persons accidentally exposed to radiumsulfate dust, due to rupture of 50 mg. capsules, have been studied from eight to twelve months. The total radium burden of the body was estimated from the rate of radon exhaled by the lungs. This was done by absorption of the gas in charcoal, measurement of radioactivity, and comparison with standard solutions. These rates showed a sharp decrease within fifteen days followed by an increase and a later steady decline. The initial decrease is possibly due to excretion of radium dust swallowed and dissolved in the gastrointestinal tract. There is less radon exhaled, when compared to the radium content, than in chronic exposure cases of soluble salts.

Gamma-ray activities of the whole body and of the thorax were measured with a scintillation counter and these findings were compared with known sources in phantoms. These measurements showed a sharp localization in the lung with a decrease of gamma-ray activity of an average half-life of the order of 120 days, during the first year.

Bioassays of the excreta for radium content were done in one subject. Retention could be computed by comparing excretion with total body burden at given intervals.

There appears to be early eliminations of radium sulfate ingested and subsequently solubilized by the gastrointestinal tract, and a relatively high elimination rate several months later due to the mobilization of radium sulfate from the lung. This rate is greater than that seen in cases of inhaled soluble radium salts.

The authors conclude that estimates of radium body burden based solely either on radon or excretion measurements are likely to be seriously in error if applied to cases of recent exposure to insoluble dusts.—*William A. Goodrich, Jr., M.D.*

LOEVINGER, ROBERT. The dosimetry of beta radiations. *Radiology*, Jan., 1954, *62*, 74–82.

With uniform distribution of beta radiation in large volumes of tissue dosimetry is relatively simple. Distribution is hardly ever uniform, however, but is locally concentrated in small regions throughout the tissue. Cells adjacent to these concentrations receive much more radiation than the cells between these "point-sources." Dosimetry of small or non-uniform sources is exceedingly difficult and has received little attention.

The basic physical information required for beta radiation dosimetry is the distribution of absorbed energy around a point source of beta particles in an absorbing material. If this point source of energy distribution function were known, it would be possible to compute the distribution of absorbed energy for any known distribution of a beta emitter.

The author reports the results of an investigation to determine the variation of doses with distance from a point source of beta rays without actually using a point source in his experiments. Measurements were made of absorption parallel to very thin plane sources, from which the information for a point source could be computed. A variable-spacing, parallel-plate ionization chamber, usually referred to as an extrapolation chamber, was used in making measurements on a number of beta emitters.

Results of such measurements on six beta-emitting isotopes are given in the form of a two-part equation. Comparison of this theoretical result with the experimental points is shown in the form of graphs. It has not definitely been established that the point source function described is applicable to all beta-emitting isotopes.—*Arno W. Sommer, M.D.*

BRUCER, MARSHALL. Teletherapy design problems. *Radiology*, Jan., 1954, *62*, 91–100.

Radium applicators and roentgen-ray apparatus, although of proved value, have some undesirable limitations. The most important of these, concerning the biological response of tissue to radiation, are not considered in this discussion. Others are inherent in the design of physical machinery, which in turn depends upon the source of radiation. With radioactive sources, it is not only possible but also practical to design machines which will respond to every demand of the radiotherapist.

It is very probable that teletherapy units can be made and maintained more economically than can roentgen therapy apparatus. Also, radioactive sources have released us from the 1 curie per gram specific activity limitation of radium, and from the cumbersome roentgen-ray generator. There are, however, very rigid limitations in the use of radioisotope sources. Among the factors to be considered in the use of such sources for teletherapy are the r/min. and kilovolt range, the maximum and minimum source skin distance, protection, and the number of sources to be used. It is recommended that the interested reader refer to the original article for the author's excellent discussion of these factors.

A review of the current status of the production of multicurie sources indicates that there are two outstanding isotopes which have a combination of advantages which make them suitable for teletherapy units: cesium 137 and cobalt 60. Cobalt 60 sources can be produced in specific activities ranging from 20 to 30 curies per gram. It is apparent that within the next few years activities up to 100 curies per gram could be made available. Cobalt sources must be replaced every five to ten years. There is a significant change in output from year to year.

Cesium sources can be produced with specific activities not exceeding 23 curies per gram. It is a waste product in the neutron economy and, once the manufacturing plant is set up, it should be the cheapest of all sources. The source must be replaced every thirty to fifty years. There is no significant change in output from year to year. However, cesium must be produced as the sulfate, and must be pressed into sealed housing. Cesium sources can be housed in shields one-fourth as massive as an equal cobalt source. Which of these two sources can be considered best for teletherapy is debatable at this time.—*A. R. Watson, M.D.*

Zinn, W. Berkeley. Body-section radiographic equipment: modifications and accessories. *Radiology*, March, 1954, *62*, 416–422.

The author describes and illustrates two modifications of the present laminagraphic equipment. These make it possible to obtain 4 exposures of successive levels on one 14 by 17 inch film, all exposures being in normal viewing position and in sequence. Film sorting is thereby largely eliminated and interpretation is considerably simplified.

Accessories consisting of lead diaphragms to be mounted on the cone are also described. These have been found to reduce the amount of radiation received by the patient and to improve the quality of the laminagrams.—*A. Ralph Watson, M.D.*

Paatero, Yrjö V. Pantomography in theory and use. *Acta radiol.*, April, 1954, *41*, 321–335.

A method of tomographic roentgenography developed by the author is described. The pantomograms produced are defined as panoramic roentgenograms of curved layers, either internal or external, of a given object. The skull by its contour lends itself most appropriately to pantomography, and the mandible is most suitable for study by this method. The author has devoted most of his attention to the mandible, although he mentions that his experiments with pantomography of the thorax also have been encouraging.

For pantomography of the mandible, the patient is placed on a rotating seat with his head fixed in an "object holder" which is a ring attached to the rotating chair. The center of the ring lies on an imaginary extension of the rotation axis of the chair. The film is placed on a separate rotating plate known as a "film holder" which is adjacent to the object holder and rotates in the opposite direction by means of friction against the object holder. Blocks of wood hold the film in an upright position in a cassette made of paper or cloth, with intensifying screens. The cassette is bent in the approximate shape of a mandible, so that the image of the various parts of the bone in the patient (the "object") will be "focused" as accurately as possible on the film. The exposure is made through a 4 mm. vertical slit in a stationary lead shield between the object holder and the film holder, which reduces horizontal secondary irradiation. Vertical secondary irradiation is controlled by a Lysholm grid in horizontal position. During rotation over an interval of twenty seconds, exposure is made of a mandible from one end to the other.

Two or three films may be placed at different points on the film holder to obtain pictures of different layers with one exposure. When two films are exposed a few millimeters apart and then viewed stereoscopically, they provide a depth of visualization which the author describes as a "plastic" panorama. More nearly conventional stereoscopic pantomograms with a vertical tube shift between the films of a pair are also used.—*Arthur S. Tucker, M.D.*

Lenzi, M. Eine neue zisterno-enzephalographische Technik. (A new method of cisterno-encephalography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, April, 1954, *80*, 479–484.

This modification of Robertson's technique elimi-

nates some of the difficulties encountered by other methods. The patient is not examined in a sitting position, but is prone on a tilted table. The angle of tilt and the speed of changing positions regulate the rise of the contrast material. The patient is in a comfortable position and able to maintain the various positions of the head (anteflexion, dorsiflexion and perpendicular to table top).

The examination is done in three phases: (1) posterior cisterns; (2) cisterna ambiens, 4th ventricle, aqueduct and dorsal portion of 3rd ventricle; and (3) middle and anterior cisterns and sulcus of corpus callosum. If desirable, ventriculography can be done immediately without changing the patient's position. Only a small amount of air (about 25–30 cc.) is required.—*Frederick M. Reis, M.D.*

BLOOR, BYRON M., WRENN, FRANK R., JR., and MARGOLIS, GEORGE. Effect of intracarotid iodopyracet (diodrast) upon cerebral blood flow. *A.M.A. Arch. Neurol. & Psychiat.*, March, 1954, *71*, 358–361.

The authors have undertaken a series of intricate and highly controlled physiological studies to determine the effect of intracarotid iodopyracet (diodrast) upon the cerebrovascular circulation. Using adult rabbits and rhesus monkeys, they injected 35 per cent and 70 per cent solutions of the contrast material at varying rates and in varying quantities while observing changes in cerebral blood flow by means of thermocouples placed in the cerebral cortex. The findings were correlated with cerebrospinal fluid pressures, electroencephalographic recordings, and blood pressure changes. Vital staining techniques were employed prior to sacrificing the animals, and the brains were examined immediately.

The conclusion was reached that the principal reaction to intracarotid iodopyracet in this study was that of vasodilatation. This contrasts with the prevailing view that arteriographic accidents are vasospastic in nature. Some of the subjects showed a transient initial vasospasm, but profound decreases in blood flow were found only when sufficient contrast material had been injected to produce both severe electroencephalographic changes and blood-brain barrier alterations. In the latter instance microscopic studies show concomitant vasodilatation, stasis, hemorrhage and edema.—*Arch. H. Hall, M.D.*

PEARSE, HERMAN E., and KINGSLEY, HARRY D. Thermal burns from the atomic bomb. *Surg., Gynec. & Obst., April*, 1954, *98*, 385–394.

The authors and coworkers have presented previous reports on the time-dose relationship for a variety of laboratory-produced thermal burns. This paper concerns the results of animal exposure to atomic bomb radiation, performed to show the applicability of the laboratory studies to the understanding, prophylaxis and therapy of atomic bomb burns. Under field conditions, thermal, chemical and radiation burns may well be present simultaneously, and be difficult to distinguish initially.

White pigs, black pigs and dogs were exposed behind clear quartz at 14 different distances, with variable times of exposure, sizes of field, filters, and fabrics. Exposure in terms of energy flux was determined using calorimeters at comparable sites.

The lesions produced were closely comparable, grossly and microscopically, to those produced from carbon arc and magnesium flash radiation for given intensity and time constants. The total skin area involved did not appear to influence the response, from a $\frac{3}{4}$ inch diameter circle to a $3\frac{1}{2}$ by 4 inch rectangle. Animals receiving only ultraviolet light did not show burns, while those receiving either visible or intrared radiation developed burns of comparable severity. Dark colored pigs had deeper burns than did white pigs, and dogs showed a greater response to a given stimulus than did pigs. The decreasing effect of absolute dose in calories/square centimeter with increasing time of application was not a factor in the atomic burns, since maximal exposure time, 0.5 second, was slightly less than that previously shown to influence response.

Specific results as related to atom bomb exposure were concerned with the burn response at different times after detonation. The initial peak energy release in the first 20 to 25 milliseconds did not cause burns. Burns created during the second peak, the fire ball, were equal to those resulting from the total thermal exposure. Major damage was caused in the first 0.3 second, maximum damage in the first 0.5 second. These results indicate that evasive action would be of little value.

Lethal exposure to ionizing radiation simultaneously did not affect the response, or the course of healing, until radiation sickness appeared.—*R. Kenneth Loeffler, M.D.*

TULLIS, JOHN L., LAMSON, BALDWIN G., and MADDEN, SIDNEY C. Mortality in swine exposed to gamma radiation from an atomic bomb source. *Radiology*, March, 1954, *62*, 409–415.

A study of the lethal dose curve obtained from exposure of 90 swine to total body ionizing radiation from an atomic bomb is presented. The authors hope that the data will eventually aid in estimating a lethal dose curve for total body irradiation in man.

In the experiment conducted, 90 healthy swine were placed in identical cages at nine target stations. The cages were designed to protect the animals from all atomic bomb energies except ionizing irradiation.

Seventy-nine of the swine died between the fifth and nineteenth day as a result of the irradiation. One hundred per cent of those which received between

320 and 1,000 r, 80 per cent of those which received 275 r, and 20 per cent of those animals which received a dose of 180 r died. From these results, it can be calculated that 100 per cent of the swine would be expected to die when irradiated with 390 r, 50 per cent with 230 r, and none with 130 r or less.—*A. Ralph Watson, M.D.*

Bauer, Göran C. H. Rate of bone salt formation in a healing fracture determined in rats by means of radiocalcium. *Acta orthop. Scandinav.*, 1954, *23*, 169–191.

The femurs of mature female rats were fractured manually, and the rats subsequently given injections of a few microcuries of radioactive calcium. At varying intervals afterwards, the animals were killed and the femurs, tibias, and incisor teeth removed. The bones were sawed across so that the metaphyseal ends could be studied separately from the shafts. Each sample thus obtained was ashed and weighed, and its activity determined, by count on a ratemeter, as per cent of the administered dose. A few representative bones were not ashed, but were used for radioautography.

The ash weights of the fractured femur shafts were found to be higher than those of the intact shafts. The increase developed gradually, until on the twelfth day following fracture it amounted to more than 15 per cent of the ash weight of the intact femoral shaft.

A rise in activity was encountered in the incisor teeth and the shafts of the long bones during a period of thirty-two days following the administration of Ca^{45}, made one week after the fractures. During the initial twenty-four hours following the administration of radiocalcium the fractured femur shafts took up more than five times as much activity as did the uninjured femur shafts. Evidently the newly built-in bone of high activity is not subjected to removal during this period.

In the metaphyseal areas, however, the bone trabeculae are subject to destruction shortly after formation. A loss of activity therefore was encountered from the ends of the femurs and tibias after the initial twenty-four hour interval.

During the period from two to five days following the injection of Ca^{45} the rate of bone salt formation in the callus of the femurs was found to be equivalent to 0.04 mg. Ca per hour. Constant rates of absorption also were found to be maintained over this interval in the intact shafts and in the incisors. Thus, the relative rate and the absolute rate of deposition of bone salt were determined, and it proved possible, with knowledge of only the rate of deposition in just one skeletal part, to obtain a figure for the rate of deposition of Ca in any other skeletal part, without a separate determination of the specific activity of the blood. The only important precaution necessary was the choice of a time interval during which resorption of the newly built-in bone would not be excessive. For the seven day old fracture callus, this period of time was from two to five days, for the shafts from two to thirty-two days, and for the bone ends about eighteen hours, following the administration of Ca^{45}.

The specific activity (per cent dose per mg. ash) of the fractured shaft is always higher than the activity of the ends of the bone. During the early intervals after the injection of radiocalcium the specific activity values are higher in the ends of the fractured bone than in those of the intact bone. Later the specific activity is lower in the fractured bone ends than in the intact bone ends, as the labeled bone salt is affected by the enhanced removal process.—*Arthur S. Tucker, M.D.*

Bauer, Göran C. H. Long term redistribution of bone sodium studied in rats by means of Na^{22} radioautography. *Acta orthop. Scandinav.*, 1954, *23*, 192–197.

Sodium, the author states, is present in bone in principally two fractions. One fraction can be accounted for on the basis of the extracellular water present in bone. The other, which cannot be accounted for on this basis, is "excess sodium." About 60 per cent of the excess sodium does not enter into exchange with the serum sodium. To study this nonexchangeable sodium, the author injected about 90 μc. Na^{22} subcutaneously into 21 six week old rats which were subsequently killed at varying intervals. Immediately after death, a serum sample, both femurs and tibias, one humerus, and the incisor teeth were removed for measurement. A 40 μ longitudinal section of each humerus was prepared for radioautography.

Growth continued in the rats throughout the experiment. The radioautographs from the animals killed within four days after the administration of radiosodium showed both shaft and ends of the bones clearly. Throughout the study of twenty-five days, the shaft and the distal metaphysis remained distinct on the radioautographs. The proximal metaphyseal portion, however, gradually faded.

The method provides a graphic demonstration of the incorporation of sodium in the bone, and its removal by resorption in the most rapidly growing portion of the bone. It does not settle the question as to whether the sodium is a part of the bone salt crystal structure or is bound to the surfaces of the crystals, although the author favors the former mechanism.—*Arthur S. Tucker M.D.*

Rust, John H., Trum, Bernard F., Wilding, James L., Simons, Charles S., and Comar, C. L. Lethal dose studies with burros and swine exposed to whole body cobalt-60 irradiation. *Radiology*, April, 1954, *62*, 569–574.

A group of 50 sexually mature burros and another

group of 49 six month old swine were exposed to cobalt-60 whole body gamma irradiation. The LD 50/30, which is defined as the amount of radiation required to kill 50 per cent of the animals in 30 days, was established.

Burros exposed to cobalt-60 had a significantly higher LD 50/30 (784 r) than did those exposed to tantalum-182 (651 r) in an earlier published study. The LD 50/30 for swine was 618 r, demonstrating that they were significantly more vulnerable to cobalt-60 gamma rays than were the burros.—*Everett E. Seedorf, M.D.*

PRYDE, ARTHUR W., and PENDERGRASS, Eugene P. An experimental study of the gastric wall thickness at the site of peristalsis in dogs. *Radiology*, April, 1954, *62*, 559–568.

This study was undertaken to determine gastric wall thickness at the site of peristalsis in dogs, employing pneumoperitoneum to visualize the serosal surface and an air-barium sulfate mixture to show the mucosal surface of the stomach in double contrast. It was shown, in dogs, that contraction of the muscularis externa is probably the major factor in producing a peristaltic wave. This is at variance with one current concept that the peristaltic wave is produced by annular waves of the muscularis mucosae and not by contraction of the entire wall of the stomach.

Gastric wall thickening was noted to be slight at the distal end of the body and to become greater as the peristaltic wave approached the pylorus. Compared with the remainder of the antrum, the pyloric wall was thicker in the absence of a peristaltic wave and showed a greater and more variable thickening during peristaltic contractions.

The studies also demonstrated that the gastric rugae are thrown into folds parallel to the axis of the stomach at the site of contraction. This may be a passive action due to the easy mobility of the gastric mucosa.

The authors suggest the possibility of similar studies in man, especially those receiving therapeutic pneumoperitoneum, to determine if the observed factors are applicable in the human.—*Michael J. Healy, M.D.*

LANGENDORFF, H., KOCH, R., and SAUER, H. Untersuchungen über einen biologischen Strahlenschutz. I. Mitteilung: Der Einfluss des Desoxycorticosterons und von Nebennierenrindenextrakten auf den Ablauf der tödlichen Röntgenbestrahlung. (Investigations of a biologic protection against radiation. I. The influence of desoxycorticosterone and adrenal cortical extract on the course of fatal roentgen irradiation.) *Strahlentherapie*, 1954, *93*, 37–43.

Groups of 40–70 mice from a 17-year old strain were irradiated with a single dose of 500 r (measured in air; 150 kv., 20 ma., 0.5 mm. Cu filter, hvl. 0.8 mm. Cu, 120 r/min., 30 cm. from focal spot to the middle of the animal).

At the end of the 30-day observation period: (1) 78.8 per cent of 70 control animals were dead; (2) 73.4 per cent of 60 mice that received 0.1 mg. of desoxycorticosterone acetate daily for 10 days were dead; (3) 65.7 per cent of 70 mice that received 0.5 mg. of desoxycorticosterone acetate every 4 days were dead; and (4) 55 per cent of 40 mice that received 500 mg. of adrenal cortical extract (equivalent to 5 gm. of fresh adrenal cortex) every 3 days were dead. A protective effect, while not quantitatively extraordinary, is thus proved to exist.

Radiation death is not, however, solely the result of adrenal cortical damage. That is just one component in radiation injury to the organism.—*Henry G. Moehring, M.D.*

LANGENDORFF, HANNS, KOCH, RUPRECHT, and SAUER, HEDWIG. Untersuchungen über einen biologischen Strahlenschutz. II. Mitteilung: Der Einfluss von Desoxycorticosteron-Kristallimplantaten und Nebennierenimplantationen auf die Überlebensrate röntgenbestrahlter Mäuse. (Investigations of a biologic protection against radiation. II. The effect of implantation of desoxycorticosterone crystals and of adrenal cortex on the survival rate of roentgen irradiated mice.) *Strahlentherapie*, 1954, *93*, 44–50.

The implantation of crystals of desoxycorticosterone or of heteroplastic adrenal cortical tissue increased the survival rate of roentgen irradiated mice. To attain such protection from radiation effect, a continuous entrance of a suitable dose of the steroids is of importance, as is the immediate initiation of such dosage after the irradiation.—*Henry G. Moehring, M.D.*

LANGENDORFF, HANNS, KOCH, RUPRECHT, and SAUER, HEDWIG. Untersuchungen über einen biologischen Strahlenschutz. III. Mitteilung: Der Einfluss des Milzschutzes und von Milz- und Leberimplantationen auf die Überlebensrate röntgenbestrahlter Mäuse. (Investigations of a biologic protection against radiation. III. The influence of shielding the spleen and of splenic and hepatic implantations on the survival rate of roentgen irradiated mice.) *Strahlentherapie*, 1954, *93*, 274–280.

Only 8 per cent of a control group survived the same general irradiation that 70 per cent survived when their spleens were shielded from radiation.

Under similar experimental conditions, the implantation of one or two homologous spleens was substituted for shielding the spleen. The protective effect was only about one-half that of shielding the spleen.

In a third series heterologous material, approximately one-fourth of a rat's spleen, was implanted; 10 per cent of the control animals survived while 28.3 per cent of the animals with such implanted material survived.

For the last series, a similar sized piece of rat's liver was implanted; 10 per cent of the controls survived while 39.5 per cent of the mice with implanted pieces of rat's liver survived.

Further investigations showed that the protective effect of implanted tissues was produced by the nuclear portions of the implants and that the implanted tissues underwent fairly rapid necrosis. Hence the conclusion is drawn that the effect is humoral rather than cellular.—*Henry G. Moehring, M.D.*

Langendorff, Hanns, Koch, Ruprecht, and Sauer, Hedwig. Untersuchungen über einen biologischen Strahlenschutz. IV. Mitteilung: Die Bedeutung Sulfhydrylgruppen-tragender Verbindungen für den biologischen Strahlenschutz. (Investigations of a biologic protection against radiation. IV. The significance of sulfhydryl bearing compounds in biologic radiation protection.) *Strahlentherapie*, 1954, *93*, 281–288.

Cysteine, cysteine and cortineurine, cysteamine, N-acetyl-cysteamine, cystinamine, and thiourea protected mice against radiation. Dithiopropanol (BAL) failed to give protection.

The authors conclude that this protection against radiation effect is dependent on the compound's being capable of transformation into part of the SH-enzymatic system. To this conclusion thiourea is an exception and thus is a possible important key to further unraveling of questions concerning this enzyme system and radiation protection.—*Henry G. Moehring, M.D.*

Langendorff, H., Koch, R., and Sauer, H. Untersuchungen über einen biologischen Strahlenschutz. V. Mitteilung: Weitere Untersuchungen über die Wirkung heterologer Nebennierenimplantate auf die Überlebensrate röntgenbestrahlter Mäuse. (Investigations of a biologic protection against radiation. V. Further investigations of the effect of heterologous adrenal implants on the survival rate of roentgen irradiated mice.) *Strahlentherapie*, 1954, *93*, 381–388.

Observations of 831 irradiated mice subjected to subsequent implantation of rat's adrenal tissue resulted in these conclusions:

Body irradiation with an absolute lethal dose (650 r) allowed no significant protective effect from subsequently implanted heterologous adrenal tissue. Adrenal cortical hormone administered after irradiation is merely substitution therapy. The radiation damage is in no way attributable to adrenal insufficiency only.

Implanted adrenal tissue fails to survive—it merely acts as a temporary depot of adrenal cortical hormone.

No material difference in protective effect is observed between intraperitoneal or subpectoral implants.

Female mice are more resistant to radiation damage than are males.—*Henry G. Moehring, M.D.*

Kepp, R. K. Die Bedeutung der Ionisationsdichte für den biologischen Effekt bei ultrafraktionierter Bestrahlung. (Importance of ionization density for the biological effect in ultrafractionated irradiation.) *Acta radiol.*, Feb., 1954, *41*, 192–200.

For inherent technical reasons, particle accelerators (linear, betatron, synchrotron) produce a pulsating, high energy beam, of low ionization density. Comparison with roentgen rays from a 200 kv. generator, in taking physically equivalent air doses, revealed a significantly greater biological effect of the conventional radiation. These tests, in the author's opinion, disregarded the fact that, by its discontinuous nature, the multimev. electron or roentgen-ray beam is actually an ultrafractionated radiation.

Consequently attempts were considered to determine whether ultrafractionated radiation of various ionization densities could influence the biological effect. Within certain time limits, continuous radiation of low ionization density may be obtained from a Van de Graaff device, but none was available. There is no known radioactive isotope capable of delivering a comparable amount of continuous radiation. The author had at his disposal a 6 mev. betatron (Siemens-Reiniger), yet it could not be regulated for lower energies, and its impulse-pause ratio was somewhere between 1:200 and 1:2,000.

In the presently performed experimental series, the sources used were soft roentgen rays of 0.1 mm. Cu, half-value layer, and radium, weakly filtered with 0.2 mm. monel, so as to allow passage of over 80 per cent of the beta-ray emission. Ultrafractionation was achieved with a stroboscopic lead-lined copper disk (obviously the 12 per cent gamma radiation of radium was not fractionated). Equivalent r air dosage was determined with a conventional thimble chamber, the wall of which absorbed an unknown amount of electrons; thus radium dosage was actually higher than measured. Equivalent dose evaluation was also checked by densitometric comparison of exposed film strips.

Ultrafractionated radium and roentgen rays

caused slightly higher death rates among 4.5 hour old eggs of *Drosophila melanogaster* than the respective continuous radiation. Conversely, for colonies of *Escherichia coli* and root tip cells of barley (*Hordeum vulgare*), ultrafractionated roentgen radiation was slightly, radium significantly less effective, than the continuous beams. This response seems to indicate a deviation from what would be expected in the case of a one-hit target action damage.

Varying the impulse rate, under constant impulse-pause ratio (1:10.4), exposure of *Drosophila* eggs to radium showed a maximal damage at 133.3 impulses/sec., the dose rate being 22 r/min. The effect decreased on additional elevation of the impulse rate, unless the impulse-pause ratio was also altered. The dosage being equal, the effect appears proportional with the impulse-pause ratio.

The author declines to draw definite conclusions from these results, yet in his opinion they agree with his initial assumption and seemingly warrant further investigation along these lines.—*E. R. N. Grigg, M.D.*

WHEATCROFT, M. G., and MORGAN, J. E. Absorption of x-rays by tissues of the head and neck. *Radiology*, March, 1954, *62*, 423–426.

Since pertinent data concerning doses received by the salivary glands, teeth, and jaws following unilateral and bilateral roentgen irradiation could not be found in the literature, the authors conducted experiments on 3 dogs to determine these doses. A Victoreen condenser r-meter was used to measure the amount of roentgen rays received by each of the given areas under study. It was found that during bilateral irradiation of the salivary glands, the parotid glands received a larger dose than any other tissue, and this was approximately 60 per cent more than the calculated air dose. During bilateral irradiation of the teeth and mandible, the skin received a larger dose than the other tissues, and this amounted to approximately 50 per cent more than the calculated air dose. During bilateral exposure, the total dose to any tissue was found to be the arithmetical sum of the individual doses from each side, and this varied according to tissue absorption.

These data appear to be of some interest in clinical radiology, since bilateral exposure techniques are frequently applied in cancer of the oral cavity. While conditions of this experiment tend to exaggerate the importance of scattered components, due to large field area, the same tendencies may also be observed to a lesser degree when smaller cone apertures are used.—*A. Ralph Watson, M.D.*

SEEMANN, H. E., and SPLETTSTOSSER, H. R. Some physical characteristics of Potter-Bucky diaphragms. *Radiology*, April, 1954, *62*, 575–583.

Using a water phantom the effectiveness and some of the physical characteristics of Potter-Bucky diaphragms were quantitatively studied. The following conclusions were reached.

Using roentgen rays generated at 70, 90, and 125 kvp. to irradiate the phantom, the scattered roentgen-ray intensity decreased almost linearly with angle from the direct beam between 8 and 54 degrees, with the scatter from the softer primary rays falling off somewhat faster than that from the harder primary rays.

The primary beam transmitted by the phantom, with scatter included, was found to be somewhat harder than the scattered radiation. The scattered radiation became a little softer with increasing angle from the primary beam.

The efficiency of Potter-Bucky diaphragms was found to increase with grid ratio and with decreasing kilovoltage.

The absorption of primary radiation by grids of high ratio is greater than for those of lower ratio because slight angular deviations from the ideal in strip assembly and small out-of-focus features are more serious in the former than in the latter.

Within the limits of experimental error, no difference in grid efficiency was observed whether used in a single-stroke or in reciprocating mechanism.

The secondary radiation from the grid itself is too small to be an important factor in the contrast in the image area, although it may be objectionable in the periphery. Application of tin to absorb the K fluorescence of lead is considered impractical.—*Charles L. Stevenson, M.D.*

RUPPERSBERG, G. H. Zur Dosismessung von Röntgenstrahlen mit luftäquivalenten Festkörpern. (Dosage measurement of roentgen rays with air-equivalent solid materials.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, March, 1954, *80*, 372–381.

The author set out to solve the problem of finding a chemically uniform material which when being irradiated with roentgen Bremsstrahlen of various qualities would show an intensity of fluorescence equivalent to ionization in air.

After discussing the theory of the air equivalence of solids, the author arrives at a formula for the calculation of the "effective atomic number" of compounds and gas mixtures which is practically identical with that suggested by Fricke and Glasser in 1925. The "effective atomic number" of air is about 7.7. Very few of the better known compounds have an effective atomic number of 7.7 but the author presents a table of 94 lesser known air-equivalent cyclic compounds between C_6 and C_{25}. A number of these substances were compressed into small tablets and the intensity of their fluorescence was compared with ionization in air for 17 different qualities of roentgen rays with half-value layers in copper from 0.125 mm. (55 kv.) to 1.58 mm. (200 kv.). A thin

layer of sodium salicylate embedded into a thin layer of a non-fluorescent air-equivalent compound proved to be the most satisfactory substance for dosage measurements. Within the range of radiation qualities mentioned, the intensity of its fluorescence was running parallel to that of ionization in air and independent of the wave lengths of the radiation.

The author feels that sodium salicylate is suitable for dosimetry of roentgen rays within the entire range of photoelectric and Compton absorption.—*Otto Glasser, Ph.D.*

Richardson, Jasper E. Effect of chamber voltage on electron build-up measurements. *Radiology*, April, 1954, *62*, 584–588.

The procedure of reversing the polarity of the voltage applied to an ionization chamber and taking the average of the readings at each polarity is used to eliminate errors caused by stray currents which are independent of the chamber voltage. The difference in readings is usually small but can be significant in electron build-up measurements.

The author made a careful investigation of the effect of chamber voltage on electron build-up measurements. He found the difference between readings (a) to be independent of the magnitude of the chamber voltage, until the voltage became too low to collect all ions, (b) to decrease with increase in absorber thickness, and (c) to decrease, and sometimes to reverse, with increase in electron contamination of the beam.

It is advisable that the voltage be reversed and readings be taken for each polarity, when parallel-plate type ionization chambers are used for electron build-up measurements. The average of the two readings is the true ionization within the active volume of the chamber.—*Arno W. Sommer, M.D.*

Sampson, D. Alan. Wide-angle trifocal eyeglasses for radiologists. *Radiology*, Feb., 1954, *62*, 255–258.

Each lens of trifocal eyeglasses consists of three instead of two components as in bifocals. The upper component or segment carries a correction for distant vision, the lower segment is corrected for near vision while the intermediate segment carries the correction for middle distances.

Trifocal eyeglasses of various patterns have been tested in an attempt to find the optimum size and shape for the middle segment.

For film reading an intermediate segment of 10 mm. has been found desirable, with its lower limit at the pupillary line. A "rainbow" pattern seems to be most satisfactory. The author feels that surgeons at the operating table, dentists and others will probably find "working trifocals" of this pattern a useful adjunct.—*Donald N. Dysart, M.D.*

Pollack, Herbert C., and Bridgman, Charles F. X-rays in philately. *Radiology*, Feb., 1954, *62*, 259–261.

Unscrupulous persons will at times attempt to increase the market value of a damaged genuine postage stamp. This they do by repairing torn or thin areas of the paper, adding paper to narrow margins, replacing perforations that have been torn off, chemically removing cancellations, and redrawing the design where damaged. Such repairs or alterations when skillfully done may even escape detection by the microscope or with use of ultraviolet light.

The authors describe the use of roentgen rays to study the minute details of the design, paper texture, watermark, and cancellation of the postage stamp. Three different techniques: low voltage roentgenography, autoelectronography, and electronography are employed in such analyses. The application of each of these techniques is presented.

Two roentgenograms showing altered stamps are reproduced.—*Donald N. Dysart, M.D.*

Elkin, Milton, Ettinger, Alice, and Phillips, Robert I. Simple determination of tomographic levels. *Radiology*, Feb., 1954, *62*, 198–202.

Since the proper localization of the level for laminagraphy of a sharply defined object is sometimes difficult, a method using the principle of triangulation for such localization is presented. The actual depth of the lesion can be calculated by simple arithmetic, or by using the chart provided by the authors. Accuracy within 0.5 cm. for sharply outlined objects is obtained.

The chief significance of the above described method is that of economy in time, film and irradiation. Laminagraphy approaches the category of being a routine rather than a time-consuming special procedure.—*A. Ralph Watson, M.D.*

Taber, Kenneth W. A homemade inexpensive manual rapid cassette changer for angiocardiography and cerebral angiography. *Radiology*, May, 1954, *62*, 728–732.

The author describes in detail a manual rapid cassette changer which can be made in the home workshop at a cost of less than sixty dollars. Exact specifications and methods of operation in angiocardiographic and cerebral angiographic procedures are given.

The two main advantages of this cassette changer over some others previously described are, (1) a stop watch timing device to control injection-exposure intervals to coincide more nearly with ether and decholin times, and (2) a film channel of sufficient length to act as an arm board and operat-

ing table when a cut-down is necessary with the patient in position for angiocardiography.—*Michael J. Healy, M.D.*

EQUEN, MURDOCK; ROACH, GEORGE; BROWN, ROBERT, and BENNETT, TRUETT. The value of the fluoroscope in the removal of foreign bodies from the air passages, the esophagus, stomach and duodenum. *South. M. J.*, May, 1954, *47*, 437–440.

The value of the fluoroscope in the localization of foreign bodies in the esophagus, stomach, duodenum and tracheobronchial tree is re-emphasized.

With the aid of suitable magnets, the authors have been able to remove all magnetic foreign bodies with the exception of three in the last ten years. Usually the monoplane fluoroscope is used, but experience with the biplane fluoroscope is also described.

Parents are urged to purchase only magnetic straight pins, safety pins and bobby pins because of the fact that the use of the proper magnet with fluoroscopic control offers the simplest and safest method for the removal of foreign bodies.—*Fay H. Squire, M.D.*

GOULD, SYLVESTER E., GOMBERG, HENRY J., and BETHELL, FRANK H. Control of trichinosis by gamma irradiation of pork. *J.A.M.A.*, Feb. 20, 1954, *154*, 653–658.

About 1.5 per cent of all hogs slaughtered in the United States are infected with larvae of *Trichinella spiralis*. The authors believe that, as a result of eating trichinous pork about 25 per cent of all Americans during their lifetime will harbor the parasite in their muscles. The average mortality among persons with clinical trichinosis in the United States is 5 to 6 per cent.

Of all pork produced, only the relatively small portion that is processed by heating, freezing, or other method, according to governmental regulations is free from danger of trichinosis. Raw pork bearing the stamp "U. S. inspected and passed" carries no warranty that the pork is free from trichina infection. Microscopic inspection of specimens of pork from the carcass of every hog slaughtered is practiced in Germany and some other countries, but is regarded as impractical in the United States. Treatment of garbage fed to hogs is one means of preventing the infection of hogs. This may be done by heating or by low temperature (−37° C.) treatment, but these methods are not in general use. In actual practice in the United States, the principal method for protection against trichinosis is adequate cooking of pork. This means that at the present time the responsibility of cooking pork adequately rests principally on the housewife or cook.

It was decided to determine the effect of irradiation of trichinous pork as a possible means of controlling the disease in swine and man. In a previous study it was found that in using 200 kv. roentgen rays a relatively large dose (750,000 r) was required to kill the larvae in vitro. However, much smaller doses (3,500 to 5,000 r) are effective in preventing the reproduction of trichinae. It is obvious that a dose that will either produce sterility of the adult trichinae or prevent maturation of the larvae to adult forms will break the trichina cycle, and thus prevent the development of the muscular phase of trichinosis in the potential host. However, this may not prevent the development of gastrointestinal symptoms in the host, which occur in about half the clinical cases as a result of irritation of the small intestine by the parasites which partially penetrate the mucosa. It was found that a dose of 11,830 r to trichinous pork was sufficient to produce sterility in 100 per cent of female adult trichinae recovered from the intestines of rats which had been fed the irradiated pork.

In the present study, it was decided to determine the effect of gamma radiation on the larvae. For this purpose, cobalt-60 and the waste fission material contained in old nuclear fuel rods were used. With cobalt-60 it was found that a dose of 18,000 to 20,000 r to trichinous pork was sufficient to prevent maturation of the larvae. As a practical measure it seemed advisable to allow a margin of safety of about 50 per cent, so the dose of radiation recommended for prevention of maturation of the larvae should be increased to 30,000 r. Similar results were obtained by radiation from the fission products. There is, of course, no radiation stored in the meat as a result of gamma irradiation, and there is no known harmful effect that can be produced in a person from ingestion of such irradiated meat. There were no flavor changes detectable by taste, and no known deleterious effects were induced in pork exposed to approximately 40,000 r of irradiation with cobalt-60. These results indicate that exposure of all raw pork to gamma radiation of waste fission products may be a practical means of controlling trichinosis in man and pig.—*D. S. Kellogg, M.D.*

RUGH, ROBERTS. Chronic low-level exposures of young mice to ionizing radiations and the effect on fertility. *J. Pediat.*, March, 1954, *44*, 248–257.

The author conducted a systematic study related to the fertility in mice exposed to ionizing radiations. The purpose was to determine the effect of weekly injections of radioiodine (NaI^{131}) and parallel exposures to roentgen rays of both male and female mice beginning at two months and continuing through the normal reproductive period to one year of age.

Two hundred and twenty-five mice were exposed to low weekly doses of roentgen rays or radioiodine

(subcutaneous injection) for forty-four weeks beginning at the time of weaning (7 weeks) and were sample tested at monthly intervals for fertility. At the termination of the experiment, all gonads were examined histologically.

The experimental mice survived the duration almost as well (79 per cent) as did the controls (84 per cent). The highest mortality (32 per cent) occurred among those mice receiving weekly injections of 2 μc. of I^{131} (not 4 μc.).

None of the males showed a statistically significant drop in fertility when compared with the controls. This statement applies equally to those exposed to weekly doses of 10 r roentgen rays (aggregate 440 r) or to 4 μc. of I^{131} (aggregate 176 μc.). All surviving males tested at the termination of the experiment were fertile.

The females in all categories, controls and experimentals, showed a drop in fertility when compared with males—either over-all fertility or fertility with progressive time.

Radioiodine at the dose levels used was not sterilizing with respect to the ovary although with increasing doses there was a lowering of fertility. The over-all fertility of 4 μc. of I^{131} females was 47 per cent as compared with 73 per cent for the controls. The histological analysis of these ovaries showed a wide range of response, some appearing quite normal, even at 4 μc. of I^{131} per week and others at 2 μc. of I^{131} per week developing large edematous areas, anovular cortices, and early evidence of neoplasias. Every ovary had some normal follicles, and most ovaries showed some areas of histological damage.

Whole body roentgen irradiation to 10 r per week for forty-four weeks produced completely sterile ovaries in every instance. There was no evidence of any follicles anywhere and the cortex was thickened and pigmented while the stroma (medulla) appeared fibrotic and made up of columns of cells simulating the sex cord cells of the differentiating gonad.

The female mice receiving 10 r whole body roentgen radiation weekly were completely sterilized after the seventh month or following an accumulated exposure of 280 r. Many were sterile at an earlier stage (*i.e.*, fifth month following 200 r). The over-all fertility (fertility tests of all females over the 11 months) was 22 per cent as compared with 73 for the controls.

The author concludes from his study that beta, gamma, and roentgen rays are more damaging to the ovary than to the testes; that 10 r of roentgen rays is more deleterious than 4 μc. of I^{131} given weekly; and that when given at weekly intervals, an accumulated dose of 280 r of roentgen rays appears to be completely sterilizing for the female mouse, while a dose of 440 r over forty-four weeks does not appreciably reduce male fertility.—*James F. Martin, M.D.*

Schneider, Martin, Wybourn, Robert C., Binhammer, Robert, and Finerty, John C. Protection of irradiated rats by parabiosis with adrenalectomized or splenectomized partners. *Radiology*, Feb., 1954, *62*, 234–240.

It has been shown in previous reports that post-irradiation parabiosis is a method of substantially reducing mortality among laboratory animals exposed to lethal dosages of roentgen radiation. The present study represents a further attempt to corroborate earlier work on postirradiation parabiosis and to determine whether the adrenals and the spleen in a parabiont are essential for protection of its irradiated partner.

The animals were divided into three groups of litter mates, one of each pair receiving an LD 96 thirty-day dose of roentgen radiation (700 r). Twenty-three normal-normal pairs served as controls. Parabiosis was accomplished by the method of Bruster and Meyer. At the time of surgery, all of the adrenalectomized animals were injected with 0.2 ml. of lipoadrenal extract to protect them until functional vascular anastomosis with the partner was established. The animals were separated after thirty days and observed for an additional thirty days. One group of pairs consisted of irradiated-normal parabionts in which survival at thirty days was 81 per cent. The irradiated-adrenalectomized pairs showed a survival of 59 per cent in the same period, whereas the irradiated-splenectomized pair showed 68 per cent survival.

The conclusion is drawn that post-irradiated parabiosis permanently protects a large majority of rats from the lethal effect of irradiation and that the presence of adrenals or spleen in the non-irradiated partner does not significantly alter the degree of protection of the irradiated parabiont.—*Michael J. Healy, M.D.*

Ross, J. A. T., Leavitt, S. R., Holst, E. A., and Clemente, C. D. Neurological and electroencephalographic effects of x-irradiation of the head in monkeys. *A.M.A. Arch. Neurol. & Psychiat.*, Feb., 1954, *71*, 238–249.

In this experiment roentgen rays were delivered to the heads of 37 monkeys with complete shielding of their bodies. The physical factors were 250 kv. (peak), 0.5 mm. Cu and 1 mm. Al filters, 118 r per minute and a half-value layer of 1.4 mm. Cu. The monkeys were rotated at a rate of 1 r.p.m. Single doses of 6,000 r, 4,500 r, 3,000 r, 2,000 r, and 1,500 r were given. Physical examinations, electroencephalographic recordings and rectal temperature readings were made before and at intervals after irradiation. Blood counts were made periodically.

The findings in the monkeys treated with 6,000 r and 4,500 r were the same. They appeared normal for two hours after the treatment, then became apathetic, would not eat or drink and eventually passed into a terminal coma. They showed marked facial

and brain edema. There was no vomiting or diarrhea. Within fifty-five hours 12 of the 16 treated monkeys died. Two lived twelve days and these developed facial ulcers and alopecia. They developed myoclonic twitching, blindness, loss of pupillary light reflex, and moderate drop in temperature. Those that lived longer developed seizures.

The monkeys getting 3,000 r lived longer. They did not develop radiation sickness and lost no weight until about one week before death. Their general behavior remained normal for about ten days when their activity gradually diminished. Multiple ulcerations appeared at about four weeks after irradiation. The early neurological changes were similar to those in the 6,000 r group. Later coarse jerking and seizures occurred. There was no blindness. Some monkeys developed tumors and some spastic paralysis.

In the 1,500 r and 2,000 r group there were no changes during the first week. Anorexia became apparent during the second week. A sharp mucositis occurred in the mouth, nose and eyes in about two weeks, and facial ulcers appeared. There was definite general improvement after the fourth week. At the end of two months the animals returned to normal health. Six monkeys were allowed to live six and eight months, and they remained in good health. There were relatively few neurological changes in this group. There was some poor coordination and a few tremors.

In all groups the temperature rose 1–3 degrees by the fourth hour and then returned to normal. The temperature in the 6,000 r group steadily dropped below normal until death.

The lymphocyte count dropped in about twenty-four hours and the neutrophil count became elevated. Within four days the counts returned to normal in the surviving animals. In the 6,000 r group there was marked increase in intracranial pressure with development of pressure cone at the foramen magnum which may have accounted for some of the deaths. There was little edema in the 3,000 r group and none in the 2,000 r or 1,500 r groups. The greatest damage was in the hypothalamus, optic chiasm, and medulla. The principal injury occurred in the neuronal and neuroglial elements.

The threshold of injury appeared to be at about 1,500 r given in a single dose. Maximum survival dose for irradiation of the head was at about 2,000 r. Radiation sickness as manifested by the usual gastrointestinal and hematological signs was not observed in these cases.—*Frank M. Windrow, M.D.*

NORDENSTRÖM, BJÖRN. Pulmonary circulation time; a densometric study. *Acta radiol.*, March, 1954, *41*, 209–224.

The effect of temporary occlusion of a pulmonary artery on the circulation time through the contralateral lung was studied in a series of experiments on 21 dogs. Thirteen dogs were used in a preliminary series in development of the method, and 8 dogs were used in determination of pulmonary circulation time. In 6 of the 8 the effect of unilateral pulmonary artery occlusion was studied.

The pulmonary circulation time was measured by a densometric method. The electrokymograph was used to determine the transit time through the pulmonary circulation of small amounts of contrast medium, before and after occlusion of the pulmonary artery. The two photo tubes were centered over the pulmonary artery and left auricle (in one case tube 2 was placed over the ascending aorta). By automatic syringe a measured amount (2.2 ml.) of opaque medium was injected into the right auricle or the pulmonary artery trunk through a catheter inserted through a peripheral vein. The intensity variations recorded as the material passed the photo tubes made it possible to measure the time of circulation through the lungs. Occlusion of the pulmonary artery was accomplished by passing a second catheter, to the end of which a small balloon was attached, into the pulmonary artery and then inflating the balloon by the injection of contrast medium.

In every case the pulmonary circulation time was shortened (but by less than 50 per cent) when one pulmonary artery was occluded. It is suggseted that this relative change in circulation time of contrast medium may be due to two factors: (1) A corresponding change in circulation time for blood. (2) A change in the volume of blood circulating through the lung. —*Lois Cowan Collins, M.D.*

CROUSE, HELEN V. X-ray breakage of lily chromosomes at first meiotic metaphase. *Science*, April 16, 1954, *119*, 485–487.

In the author's own words, "The studies on lily chromosomes described in this article demonstrate that x-rays produce an effect on fully condensed meiotic (first metaphase, M I) chromosomes which is clearly detectable at the first meiotic division (first anaphase, A I), not in the form of chromosomal or chromatid aberrations, but in the form of bridges here interpreted as *half-chromatid bridges*."

The primary purpose of this paper is to present the results on sporocytes irradiated at M I and examined at A I and shown in author's Table 1. A photomicrograph and a camera lucida drawing show an A I bridge that is interpreted as a half-chromatid bridge. The chromosome involved has a subterminal centromere and, hence, very unequal arms. Eleven tetrads have undergone normal anaphase disjunction; the twelfth has formed a half-chromatid bridge, the structural detail of which is shown in the drawing. This bridge is distinctly different from a chromatid bridge in that no acentric fragment is formed.

These studies clarify the anomaly of "potential x-ray breaks" (A. H. Sparrow, *Proc. Nat. Acad. Sc.*, 1944, *30*, 147) and simplify the interpretation of radiation effects on meiosis reached by Darlington

and LaCour (*Heredity*, 1953, supp. 6, p. 41). — *William Loehr, M.D.*

Moos, Walter S. How biological effectiveness varies with X-ray energy. *Nucleonics*, May, 1954, *12*, 46–49.

The biological effects of roentgen radiation, being due to the collisions of charged particles with atoms of the irradiated object, are affected by the phenomena of transition, absorption and specific ionization. These in turn are roentgen-ray energy dependent variables.

From work reported in the literature and from his own irradiation experiments on *Esch. coli* and *Pseudomonas aeruginosa* using roentgen rays generated at 4, 39 and 186 kv. and 2 mev., the author concludes that there is a definite dependence of the biological effectiveness of roentgen radiation on the wavelength; that this effectiveness may increase or decrease with wavelength, depending on whether the irradiated biological object is affected by a small or large number of ionizations; that under certain conditions a small number of ionizations may be enough to cause a certain effect but that in bacterial and other cells including higher organized living material probably a higher number of collisions is required to achieve effect.—*Leslie K. Sycamore, M.D.*

Gerschman, Rebeca, Gilbert, Daniel L., Nye, Sylvanus W., Dwyer, Peter, and Fenn, Wallace O. Oxygen poisoning and x-irradiation: a mechanism in common. *Science*, May 7, 1954, *119*, 623–626.

The authors state that a consideration of various isolated reports in the literature had led them to the hypothesis that oxygen poisoning and radiation injury have at least one common basis of action, possibly through the formation of oxidizing free radicals. They point out that it has been demonstrated, not only that anoxia decreases the acute lethal effects of ionizing radiations on rats and mice and on several other biological systems, but also that increased oxygen tensions enhance the effect of irradiation. They also note that both oxygen and roentgen rays produce identical aberrations of chromosomes of Tradescantia microspores, and strikingly similar histological changes in the testis of rats. Vitamin E, vitamin P, and cobalt have been shown to give some protection against oxygen poisoning and also against roentgen rays. On the other hand, insulin enhances sensitivity to irradiation and to oxygen poisoning.

In view of these considerations, the authors decided to carry out two types of experiments: (1) to test, in the case of oxygen poisoning, the effectiveness of substances that have been demonstrated to protect against roentgen rays; and (2) to test the combined effect of roentgen irradiation and oxygen poisoning on the survival of mice. In the first group of experiments, the substances known to protect against roentgen rays were also found to protect against oxygen poisoning by allowing a longer survival time. In the second group of experiments, the mice were treated with roentgen rays and oxygen, some simultaneously and others with various time intervals between the previous irradiation and the oxygen exposure.

The authors conclude that, in view of their and previous experiments, it would appear that irradiation and oxygen poisoning produce some of their lethal effects through at least one common mechanism, possibly that of the formation of oxidizing free radicals. Tables and detailed descriptions of their experiments are included.—*D. S. Kellogg, M.D.*

Durant, Thomas M., Oppenheimer, M. J., Lynch, Peter R., Ascanio, Guido, and Webber, Donna. Body position in relation to venous air emoblism: a roentgenologic study. *Am. J. M. Sc.*, May, 1954, *227*, 509–520.

The authors have been much impressed by the considerable number of deaths due to venous air embolism, and feel that the subject has far greater importance than has been appreciated.

Biplane stereoscopic angiocardiography was used to study the basic pathophysiology of venous air em bolism in dogs. The technical factors for the procedure are described in detail.

Conclusions derived are as follows:

1. Air injected into the femoral vein reaches the right heart almost instantaneously.
2. Air in pulmonary artery is coincident with systematic hypotension and disturbance of respiratory rhythm.
3. Delivery of air from ventricle to pulmonary artery, by the air buoyancy principle, is noted in the left lateral position.
4. Important role played by body position in the mechanisms which determine recovery or death is stressed.

One human case of venous air embolism is described. The most adequate therapy to recommend for application in the human is given.—*E. R. Seitz, M.D.*

Shimkin, Michael B. Pulmonary-tumor induction in mice with chemical agents used in the clinical management of lymphomas. *Cancer*, March, 1954, *7*, 410–413.

Since urethane and nitrogen mustards produce carcinogenic activity in the pulmonary system in mice, it was considered desirable to test other chemotherapeutic agents employed in the treatment of lymphomas.

Virgin female mice of strain A, three months old and weighing about 25 gm. were used.

The author tested six chemicals: (1) triethylemel-

amine, (2) myleran, (3) aminopterin, (4) stilbamidine, (5) Fowler's solution, and (6) cortisone.

The first group of mice were killed in eighteen weeks and only triethylemelamine produced multiple pulmonary nodules. The remaining animals were allowed to live for thirty weeks.

Urethane, nitrogen mustards and triethylemelamine produced multiple pulmonary tumors in 80 to 100 per cent of the mice compared to 15 per cent in the controls.

At the dose level used by the author, aminopterin, myleran, stilbamidine, Fowler's solution and cortisone did not induce pulmonary tumors.

The fact that urethane, nitrogen mustards, and triethylemelamine produces pulmonary tumors in mice should not be extrapolated to include human beings and should not restrict their use in treating lymphomas.—*John Watts, M.D.*

HURTEAU, EVERETT F., BAIRD, WILLIAM C., and SINCLAIR, ERNEST. Arachnoiditis following the use of iodized oil. *J. Bone & Joint Surg.*, April, 1954, *36-A*, 393–400.

The purpose of this paper is to present clinical and experimental data which suggested to the authors that pantopaque (ethyl-10-(P-iodophenyl) undecylate) and other iodized oils may contribute to severe and disabling arcahnoiditis.

Twelve dogs were used for their experiments. Roentgenograms showed pantopaque scattered about the cisternae basales. Gross and microscopic studies were made of the brains and attention was focused upon the meninges about the cisternae bassales. There was a meningeal reaction in all the dogs in the group which varied in intensity but tended to become more prominent as time passed. After two weeks in some of the dogs there was a severe cellular reaction in the meninges about the base of the brain similar to that seen in bacterial meningitis. Round cells, polymorphonuclear cells, macrophage infiltration and deposition of fibrin were present. No ventriculitis was evident. Several of the affected animals which had been docile before insertion became irritable thereafter and remained irritable.

There was little or no reaction to pantopaque inserted into the peritoneal cavity or in the conjuctiva. This may have been due in part to the fact that the pleural and peritoneal cavities of dogs are relatively resistant to infection.

Three cases are reported in the paper. In all of them severe arachnoiditis was proved by exploratory laminectomy. In 1 case most of the oidized oil had been removed. In the other 2 no attempt at removal had been made. In only 1 case could previous operation possibly have been a factor. The localized nature of this arachnoiditis and the presence of the fixed and completely encysted iodized oil deep within the connective tissue mass indicated that the adhesive process was, at least in part, a walling-off, foreign body type of reaction to the iodized oil. The absence of any myelographic abnormality when the oil was first inserted and the development of complete obstruction to the flow of subsequently injected oil at a level above the older walled-off oil substantiated this conclusion. Pre-existing mild arachnoiditis could not be ruled out with certainty, however.

The authors suggest that there is need for a more critical evaluation of the properties of pantopaque and other iodized oils and a more conservative approach to their use than is often practiced. The importance of the removal of the substance is evident.—*Ralph S. Bromer, M.D.*

SCHWARZ, GERHART S., and ISLAM, A. R. The use of conventional depth-dose tables in divided-port x-ray therapy; transmarginal radiation and depth-dose distribution. *Radiology*, May, 1954, *62*, 733–744.

Attention is called to the fact that in divided-port therapy the neighboring approximately parallel roentgen-ray beams entering the body contribute a considerable amount of transmarginal radiation to each other. This transmarginal radiation consists partly of radiation scattered outside the direct beam and partly of penumbral radiation due to the large focal spot. This raises the dose in the central axis of each neighboring beam significantly above that found in a single unaccompanied roentgen-ray beam of equal cross section.

The authors obtained measurements with an ionization chamber in various locations of a 30 by 30 by 30 cm. masonite phantom using divided-port techniques and those employed in conventional deep therapy. They found that the actual vlaues may be 15 to 76 per cent higher in the divided-port techniques than the routine depth dose calculations if this radiation is disregarded, depending on depth and number of beams.

A simple method is described for approximating correct tissue doses from the conventional depth dose tables when this situation exists. The authors suggest that this method should be employed whenever a large port of entrance is divided into two or more smaller contiguous or nearly contiguous ports admitting the entrance of essentially parallel beams.—*Donald N. Dysart, M.D.*